# TRICKS & TIPS of Atari ST


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# ATARI ST®™

# TRICKS & TIPS

## Valuable collection of software tools and programming hints

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# ST BASIC

# ST BASIC

Two languages are packaged with the ST—BASIC and LOGO. BASIC is the most widely used language for personal computers, of course. We won't talk about all of ST BASIC's commands. You can find out more about that in other books, such as the **ST BASIC Training Guide** from Abacus. Instead, we'll introduce some the features that are unique or peculiar to this version of ST BASIC.

If you're already familiar with BASIC on other personal computers, then you should have little trouble adapting to ST BASIC. The syntax of ST BASIC is very similar to the Microsoft BASIC on the IBM PC.

On the other hand, ST BASIC has some very impressive capabilities. In particular, ST BASIC has a very flexible interface to the GEM (Graphics Environment Manager) and to the VDI (Virtual Device Interface). These provide a convenient way to make use of many powerful ST features.

## 1.1 The special ST BASIC commands

Below is a short description of the commands unique to ST BASIC.

### FOLLOW, UNFOLLOW

The `FOLLOW` command outputs the value of simple variables when the contents of that variable change during the program run. This makes it much easier to search for programming errors. The `UNFOLLOW` command turns off the output of variable values. The syntax for `UNFOLLOW` is:

```
FOLLOW a,angle%,text$
.
. (other BASIC statements)
.
UNFOLLOW text$
```

## BREAK, UNBREAK

The BREAK and UNBREAK commands are also used for program debugging. The BREAK command halts the execution of the program when the corresponding line number is reached. At this time the following is displayed:

```
b nnn
Br
```

The b signifies the BREAK, and nnn is the line number at which the BREAK was encountered. Br signifies that you are in break mode. Program execution continues if you press the <RETURN> key.

BASIC is still in the BREAK mode. If the corresponding line number is encountered again (in a loop, for example), program execution is halted again. You can disable this with the UNBREAK command. Example:

```
BREAK 120,512,2013
UNBREAK
```

## TRON, TROFF

The TRON and TROFF commands are also used for program debugging. They may only be used in command mode.

TRON turns tracing on for the entire program. All line numbers are displayed as they are encountered during program execution.

TRON i-j turns tracing on for a specific range of lines. All line numbers with values falling between i and j are displayed as they are encountered during program execution.

TROFF turns off tracing for the entire program.

TROFF -100 turns off tracing for a specified range of lines.

## TRACE, UNTRACE

The TRACE and UNTRACE commands are additional commands for debugging, similar to TRON and TROFF. But in addition to displaying the line number of the statement being executed, the contents of that line are also displayed. The syntax is identical to TRON and TROFF.

## BLOAD

The BLOAD command loads the contents of a file to a particular range of memory. You can use the BLOAD command to load machine language programs or screen images.The syntax is:

BLOAD *filename, addr*

Here, *filename* is the name of the file to be loaded. *addr* is a memory address and is not checked for validity. You are free to load a file to any memory location. Remember that if you fail to specify a load address, a fatal error will occur. In this case, the contents of the file is loaded to the default address 0. This overwrites the important exception vectors and you'll have to reboot the ST.

## BSAVE

The BSAVE command saves a range of memory to a file. You can use this command to save a screen image or a machine language program.

The syntax is:

BSAVE *filename, addr1, addr2*

*filename* is the name under which the memory range is to be saved. *addr1* is the starting memory address and *addr2* is the number of bytes to be saved.

Examples:

```
BSAVE "screen.bin",&h78000,&h7d00

BSAVE "mprog.bin",&h7fd00,768
```

In the first example, the screen contents of the 520 ST screen of are saved to the file called `screen.bin`. In the 1040 ST, the screen memory is located at `&hf8000`.

Immediately following screen memory are 768 bytes of unused memory. This area may be used for short machine language routines, since it's not used by the operating system or BASIC. The second example saves the contents of this unused memory area.

## CALL

There are two ways of calling machine language programs from ST BASIC. The first way is to use the `CALL` command. The parameters for `CALL` specify the address of the desired routine and the values which are to be passed to it. The address of the routine must be a variable.

```
address = &h7fd00
CALL address

address = &h7fd00
value1 = 33.33
value2% = 100
z$ = "test"
CALL address(val1,val2%,100,z$,"empty string")
```

In the first example the routine is called without parameters. The machine language routine may modify all registers. The value of the stack pointer must be restored to its value upon entry to the routine. This is because the routine itself must be ended with `RTS`. If the stack pointer is not restored, your program will probably crash..

The second example demonstrates how parameters are specified in the `CALL` command. The parameters must be enclosed in parentheses and separated from each other by commas. All variable types are allowed as parameters. The parameters are converted to signed 32-bit integers. Therefore a value of 33 is passed through `val1`. For strings (`z$, "empty string"`) the address of the string is passed, also represented as a 32-bit value.

How can the data be accessed in the machine language program? When the machine language program is called, registers A0, A7, and D0 are used. A0 contains the address of the routine. You may think that this is superfluous,

because the address of the routine is normally known. You just might be surprised. Later we will show how helpful the contents of A0 can be.

Register D0 contains the number of values passed. It's contained in the lower 16 bits. This value is also very important for some applications, especially if the routine can be called with a variable number of parameters. The use of a 16-bit counter is more than sufficient. Such an enormous number of parameters cannot be placed in one BASIC line.

Register A7, the user stack pointer, contains the return address to the BASIC interpreter. Additional information is also placed on the stack. For example, you can determine the number of parameters in the register Dx with the instruction `MOVE.W 4(SP),Dx`.

With the instruction `MOVE.L 6(SP),Ax` you get the start of a table. In this table are as many long words (32-bit values) as parameters in the CALL command. In these long words are the values or addresses of the strings.

## PEEK

PEEK is a function that returns the contents of memory. In ST BASIC, PEEK can return 8-bit, 16-bit or 32-bit values.

Normally PEEK returns a 16-bit value. For example, `PEEK(0)` returns the contents at the memory locations 0 and 1. The value at memory location 0 is the low-byte, and the value at memory location 1 is the high byte.

The command DEF SEG may be used so that subsequent calls to PEEK return an 8/16/32-bit value depending on the DEF SEG setup.

To return a 32-bit value, you can use PEEK in conjunction with the DEFDBL declaration. DEFDBL is always used in conjunction with DEF SEG, PEEK or POKE.

## POKE

POKE is the counterpart of PEEK. The POKE command places a value at a specific memory location. In ST BASIC the value may be 8 bits, 16 bits or 32 bits long.

POKE normally places a 16-bit value in memory. POKE &1000, &2468 will place the hexadecimal value &68 in memory location &1000 and &24 in memory location &1001.

After DEF SEG, subsequent POKE commands place 8/16/32-bit values in memory.

Using POKE in conjunction with the DEFDBL function places 32-bit values in memory.

## DEF SEG

The DEF SEG command sets the segment address for the commands PEEK and POKE. DEF SEG or DEF SEG=0 sets the segment to the physical address 0 in memory. This is the default condition after power-up.

If a value greater than 0 is entered, the segment for PEEK and POKE is set to this address. The following example will clarify this point. To access the ST's screen memory you could do the following:

```
value = PEEK(&h7fd00)
```

Alternatively, you can set the segment for the desired address. Then the address specified for PEEK and POKE are to be viewed as relative to the start of that segment.

```
DEF SEG=&h7fd00 : REM Address following is
value = PEEK(0) : REM relative to &7FD00
```

Remember that in the first example, the contents of addresses &h7fd00 and &h7fd01 are returned (16-bit-values). In the second example, the contents of address &h7fd00 are returned (8-bit value).

## GOTOXY xpos,ypos

The GOTOXY command positions the cursor on the screen. An output command (PRINT or WRITE) then starts at this location. The cursor position specified in this manner also determines the location of the INPUT command.

The X and Y coordinates are relative to the upper left-hand corner of the screen. Constants can also be used in place of the variables, of course.

Unfortunately, the GOTOXY command to one of the several defective ST BASIC commands. The X position is not evaluated correctly. The specified value is (incorrectly) increased by two. This can lead to rather confusing results. If, however, one of the scroll bars is clicked after the output, the contents of the output window are reprinted and this time in the proper positions. You should therefore use caution when working with this command. Screen masks cannot be easily constructed at the current time.

Try this example to see the problem yourself. After the program is finished, click the output window scroll box to verify that the updated positions have changed.

```
10 GOTOXY 10,10:PRINT "Here is position 10,10"
20 PRINT "12345678901234567890"
```

Here is an example using GOTOXY in conjunction with the INPUT command:

```
GOTOXY x.pos,y.pos:INPUT value
```

## INKEY$

The INKEY$ function reads the keyboard and returns the ASCII value of the key pressed. In the current version of ST BASIC, the INKEY$ does not work properly. Characters are not read from the keyboard. This is probably because of the fact that, before the execution of each command, a test is made to see if the keys <CONTROL> and G or <CONTROL> and C are pressed. In this case the program is either ended (<CONTROL>C) completely or interrupted ( <CONTROL> G).

However, the internal keyboard buffer is regularly emptied by this test. The INKEY$ function is then so fast that during the processing, no new key presses appear in the keyboard buffer. The function will then always return with no key value. You can use the INPUT$ or the INP function to replace the INKEY$ function in many cases, however. We will describe both.

## INPUT$

The INPUT$ function is available only in a few BASIC dialects (such as the IBM PC). With this function, one or more characters can be read from the keyboard or from a file. The most interesting feature of this command is that (almost) no interpretation of control characters is made. The syntax is:

```
text$ = INPUT$(10)

a$(i) = INPUT$(10,1)
or
a$(i) = INPUT$(10,#1)
```

In the first case, 10 characters are read from the keyboard without displaying these keys on the screen. The keys <RETURN>, <ENTER>, <CONTROL> G, and <CONTROL> C can be pressed without interrupting the input. The only terminating condition besides reaching the specified number of characters is the input of <CONTROL> Z. This character, with an ASCII value of 26, is usually used in files as the identifier for the end of the file. The input of 10 characters is rarely necessary (such as for the invisible entry of a password). However, if the number is reduced to one, this command becomes a replacement for the following statement which does not function correctly in ST BASIC:

```
10 a$=INKEY$:IF a$="" then 10:' doesn't work on ST
```

The special keys of the ST keyboard, the function keys and cursor keys, do not return ASCII values. These keys cannot be read with the INPUT$ function.

In the second and third examples, 10 characters are read from a previously opened file and placed in a variable. If you work with data records of a set length, the otherwise special characters like comma, semicolon, quote, and CR (<ENTER> key) can be read without difficulty. For many applications, it's also useful for a file to be read character by character. This is possible by specifying the number of characters to be 1 as the parameter of the INPUT$ function.

## INP, OUT

On earlier generation computers with Z-80 or 8080 processors, the INP command and the OUT command are often used to address the I/O ports built into these processors. But since the MC68000 used in the ST has no port addressing, we have to figure out what these commands do in the ST, and what results they yield.

In the BIOS of the ST there are three function calls with the names BCONSTAT, BCONIN, and BCONOUT. Almost all of the system input and output to the screen, printer, RS-232 interface, MIDI interface, and keyboard processor is performed with these three calls. In assembly language, these calls are used with the number of the desired device to be accessed.

The following assignments apply:

| Number | Device/interface |
|---|---|
| 0 | Centronics interface/printer |
| 1 | RS-232 interface |
| 2 | Console (keyboard and screen) |
| 3 | MIDI port |
| 4 | Keyboard processor |

These same numbers are used with the INP and OUT commands. You can therefore address all of the interfaces directly from BASIC. For example, the command,

```
OUT (0),65
```

outputs the value 65 (ASCII value of the letter A) on the printer. You might prefer to use the command:

```
LPRINT "A"
```

Doing so seems to work just as well. But try to send the character LF with ASCII value 10 to the printer by means of LPRINT. You will soon notice its effect. The ST, or more exactly ST BASIC, sends the character sequence CR/LF, the ASCII characters 13 and 10—which is completely unnecessary. This sequence is not used at all when printing graphics with Epson printers and their compatibles. Neither the bit pattern nor the given number of graphic bytes agrees with what is expected when this sequence is received.

It gets even worse. Since the ST sends the character sequence CR/LF after every 72 characters, we get some really messed up graphics.

But don't worry. The OUT command will solve the problem in this case very nicely.

Other devices besides the printer can be accessed with the OUT command. The other interfaces are also available to us. The RS-232 interface can be fully utilized from BASIC. You can also read from the RS-232 port with the INP function. With it, a terminal program can be written for the ST in BASIC with relatively little effort.

The INP and OUT commands using device number 2 allow writing of BASIC programs under the GEM environment. The entire screen is then available. For input, the INP(2) behaves like using the function INPUT$. INP(2) has a decisive advantage, however. The function and cursor keys also return unambiguous values and can therefore be read.

The MIDI interface, both input and output, can be programmed using device number 4. Readers with appropriate instruments, such as electronic organs or synthesizers, can control their devices with ST BASIC. This is assuming that you know the protocol used for MIDI. With this knowledge, it is relatively simple to control the devices with a BASIC program.

The last possible device on our list is the keyboard. As you know, the ST has an intelligent keyboard. It contains its own processor which reads the keys, the mouse and joysticks. In addition, the keyboard processor contains a clock. Values can only be sent to the keyboard processor, since the "answer" is usually discarded by the operating system. INP(4) always returns the value 16.

## VARPTR

VARPTR is a function that returns an address. A variable or file number is passed to the VARPTR function as the argument:

```
OPEN "I",1,"xyz.dat"
? VARPTR (#1)
```

In this example we can make no reasonable interpretation of the return value. This version of ST BASIC does not correctly support VARPTR using a file number.

```
a$ = "TEST"
ad = VARPTR (a$)

a = 10
adr = VARPTR (a)
```

In these two examples, the interpretation is relatively simple. Let's look at the first case.

After the VARPTR function is used, the variable ad contains the address of the string a$. The string descriptor itself consists of six bytes. The first byte of the string descriptor contains a flag whose function will be explained shortly. The second byte in the descriptor specifies the length of the string. Since the maximum value contained in a single byte is 255, the maximum length of a string is 255. The third through sixth bytes contain the address at which the string itself is located in memory.

But if you check these values with the example above, you will be amazed at the string address. The "address" turns out to be the string itself. All strings which are one to four characters long are stored directly in the "address" of the string descriptor. Try changing a$ = "TESTER" and check its address.

This also clarifies the meaning of the flag, the first byte of the descriptor. If a zero is entered here, the string is less than five characters—therefore placed in the descriptor itself. If the hexadecimal value 10 is entered here, however, the contents of positions three through six are the actual memory address of the string.

Using the VARPTR function for numerical variables returns the memory address at which the number is to be found. Real numbers are stored in four bytes. Integers (such as A%) are stored in two bytes. We will take a closer look at integer arrays later, since they are well suited for protecting small machine language programs in memory.

## SOUND

The SOUND command of ST BASIC is quite capable and very easy to use. The sound chip in the ST is the YM-2149. This IC is compatible to the well-known AY-3-8910, which is used in various other computer systems (such as MSX computers). This chip offers a broad range of capabilities for

creating sounds over three different voices. In addition, an external noise source can be combined to allow the creation of special effects (like drums or explosions).

The SOUND command has a maximum of 5 parameters, specified as numerical values. The syntax is as follows:

```
SOUND voice,volume,note,octave,duration
```

The value of *voice* can be 1, 2, or 3 according to the desired voice.

The value of *volume* is 1 and 15; 1 is soft and 15 is full volume. This value is stored according to the voice in bits 0-3 of register 8 (voice 1), 9 (voice 2), or 10 (voice 3).

The variable *note* allows values between 1 and 12. Since an octave consists of 12 steps, notes can be played directly.

The *octave* can be between 1 and 8, meaning that the ST can create sounds over eight octaves.

The *duration* can accept values between 1 and 255. The duration is measured in 20 milliseconds. If you specify a duration of 50, a tone lasting about 1 second is produced.

The following table shows the assignment of notes to numbers for the variable *note*:

| | | |
|---|---|---|
| 1 C | 2 C# | 3 D |
| 4 D# | 5 E | 6 F |
| 7 F# | 8 G | 9 G# |
| 10 A | 11 A# | 12 H |

The concert pitch A (440 Hertz) can be created with the SOUND command:

```
SOUND 1,15,10,4,255
```

Octave 4 is the one normally designated as octave zero. Smaller octave values result in deeper tones; higher values create higher tones.

## WAVE

With the SOUND command alone you can program very nice single-voice melodies, but they become more interesting and polyphonic with the WAVE command. This command gives us many more sound capabilities. It is also harder to understand. It took us a lot of work to understand the construction and the parameters. For complete understanding, an exact knowledge of the hardware construction of the sound chip is useful.

Like the SOUND command, the WAVE command also has five parameters. The first parameter is comparable to the *voice* parameter of the SOUND command. With it, the voice that creates the tone can be selected. The possible values are somewhat different here, however.

The best way to understand WAVE is to take a closer look at a special register in the sound chip. This is register 7, called the multi-function register. If bit 0 of register 7 is set, voice 1 is turned off. If bit 1 is set, voice 2 is turned off. If bit 2 is set, then voice 3 is turned off. A cleared bit creates the tone programmed for the voice.

Bits 3 to 5 are responsible for switching noise to the three voices. Here too, the function is enabled with a cleared bit, while a set bit turns the sound off for the corresponding voice.

Bits 6 and 7 are responsible for programming the data direction of the two universal 8-bit ports integrated into the sound chip.But as these two bits have no function in sound creation, we will not discuss them further here.

The bits 0 to 5 can be manipulated with the first parameter of the WAVE command. If the parameter is viewed as a binary value, the individual bits of the parameter have exactly the reverse function. If the value 1 is passed as the parameter, bit 0 of register 8 is cleared, causing voice to be turned on. All other bits of register 7 are set, turning all of the other functions off. If, for example, this parameter is 37 (%100101 in binary), voices 1 and 3 are turned on and voice 2 is turned off. In addition, the noise source is switched into voice 3. If the first parameter is zero, all the voices and noise sources are switched off.

The second parameter of WAVE affects three registers of the SOUND chip at the same time. These are the registers 8, 9, and 10. Not all bits are affected, only bit 4. Bit 4 in the three registers named determines if the volume of the three voices is affected by the specification of SOUND (contents of bits 0 to 3 of the three registers; see SOUND) or through a hardware waveform.

The hardware waveform is a special feature of the sound chip. By using the waveform, the volume of the tone is changed periodically or even just once. The waveform offers many possibilities for changing the sound of a tone.

The second parameter must also be viewed as a binary value. The following list shows the meaning of the bits in the WAVE command:

| Bit number | Function |
|---|---|
| 1 cleared | volume voice 1 from bits 0-3 reg 8 |
| 1 set | volume voice 1 via waveform |
| 2 cleared | volume voice 2 from bits 0-3 reg 8 |
| 2 set | volume voice 2 via waveform |
| 3 cleared | volume voice 3 from bits 0-3 reg 8 |
| 3 set | volume voice 3 via waveform |

The value range is thereby set to 0 through 7. If the value 0 is passed as the second parameter, the volume of all three voices is determined by the volume given in the SOUND command. For a value of 5, the volume of voices 1 and 3 are manipulated by the hardware waveform, while voice 2 runs via the volume set in bits 0 to 3 of register 9.

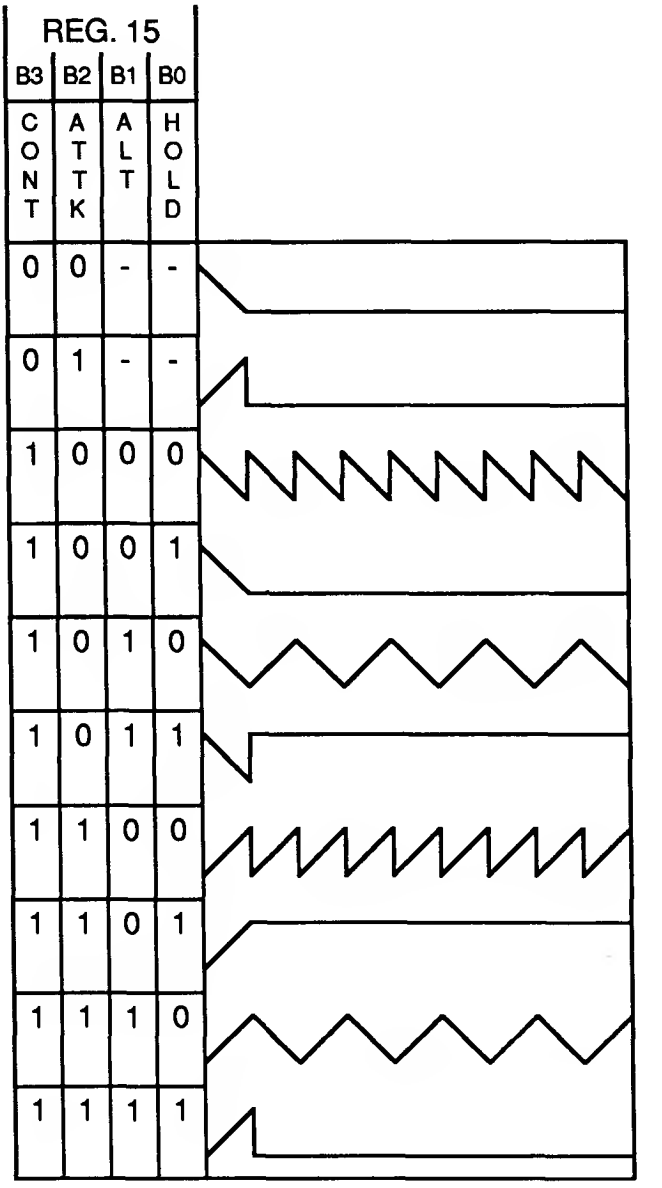
The third parameter of the WAVE command has a close relationship to the second parameter. This parameter selects one of the 9 different waveforms. The possible values can lies between 0 and 15, but some values create identical waveforms. The possible results are difficult to describe with words. Accordingly, the values and their corresponding waveforms are found in Figure 1.

The fourth parameter also manipulates registers in the sound chip directly, as well as their relationship to the waveform. The sound chip contains two 8-bit registers whose contents affect the period of the waveforms. The value of this parameter ranges from 0 to 65535. The larger the value, the longer the period of the waveform. For extremely small values (<1000), the waveforms are at such a high frequency that an additional audible frequency results. This can be used for various special effects.

The fifth parameter determines the length of the tone to be created. It is only effective in the program mode if another SOUND or WAVE command follows. In the direct mode or from the editor, the tone continues until a key is pressed, i.e. until the next mouse click.

Figure 1

## Programmable Sound Generator Waveforms



## LINEF

The LINEF command is the simplest graphic function of ST BASIC. With this command, arbitrary points or lines can be drawn on the screen. Four parameters are required to specify the starting and ending coordinates of the line. A line width of one point is preset. Later we will show how to change not only the line width, but also the line pattern and appearance of the starting and ending points.

```
LINEF 10,10,50,40
```

The line is drawn from coordinate 10,10 to coordinate 50,40.

## CIRCLE

The CIRCLE command is for creating draw circles or arcs on the screen. Either three or five parameters are required. Three parameters are required to draw simple circles. The first two parameters determine the X and Y coordinates of the center of the circle, and the third parameter is the radius in screen units. The fourth and fifth parameters are required only to draw arcs. These then specify the start and end angle in degrees. Note that the angle is specified in tenths of a degree.

The following command would create a half circle with a radius of 100 points:

```
CIRCLE 320,199,100,0,1800
```

Enter this line to see the zero point for the angle specification as well. The circle is always drawn counterclockwise from the 3 o'clock position.

Also, the line width is also set to one pixel for the CIRCLE command. We'll show you how to change the line width later.

You'll notice that the circle isn't really a circle at all. CIRCLE can only draw a polygon that approximates the shape of the circle. If you use a radius of 30 you can see that the resulting shape is not a circle, but an octagon. If you need a "real" circle, you have to calculate the values yourself and draw it with the LINEF command.

## PCIRCLE

The PCIRCLE command also draws a "circle" or arc. The required parameters are identical to those of the CIRCLE command. This circle, however, is filled with a color or pattern. The color and pattern are set with the COLOR command.

## ELLIPSE

In addition to the circle shape, ST BASIC has a command to draw an ellipse or partial ellipse. For this reason the ELLIPSE command has either four or six parameters. The first two parameters specify the X and Y position of the origin, while the following two parameters specify the radius of the ellipse in the X and Y direction. The (optional) parameters 5 and 6 specify the angle of a segment to be drawn. These last parameters are the same as for the CIRCLE command.

```
ELLIPSE 320,200,100,30,450,2700
```

## PELLIPSE

The "P" in front of the name again designates that the resulting shape will be filled with the current color and pattern. The parameters are identical to those of the ELLIPSE command.

## COLOR

The COLOR command sets the character color, the color of the fill pattern, the color of lines drawn with LINEF, and the pattern used when filling screen sections. A total of five parameters are required.

The first parameter specifies the color for subsequent text output. Only the values 0 and 1 are possible with monochrome monitors. If 0 is used as the parameter, the text will be "invisible" i.e. in the background color. With a color monitor, the value of this parameter depends on the display mode. In low-resolution mode (320x200), the value range is from 0 to 15. In medium-resolution mode (640x200), the values range from 0 to 3.

The second parameter specifies the color for the next PCIRCLE, PELLIPSE, and FILL command. The values correspond to those of the first parameter.

The third parameter determines the color of the lines drawn.

The fourth parameter determines the style used when something is filled:

| Value | Fill |
|---|---|
| 0 | no fill |
| 1 | solid fill |
| 2 | patterns |
| 3 | hatching patterns |
| 4 | user-defined pattern |

Currently, the last pattern (4) is defined as the Atari logo, ⎍.

The fifth parameter determines the selection of the pattern (0-24) or hatching (0-12). If this value is 0, no pattern is drawn, independent of other settings.

## FILL

The FILL command allows you to fill arbitrary areas. The settings for fill are made with the COLOR command. The first two parameters for FILL specify the X and Y coordinates of a point within the area to be filled.

The third parameter is optional. It's a color number representing the screen coordinate that limits the boundaries for the filling. If this parameter is omitted, then the fill is bounded by any color except the background color.

## FULLW

This command is one of several commands for manipulating windows. With the FULLW command, any one of the four windows can be set to maximum size. The four windows present in BASIC are accessible via the following numbers:

| | |
|---|---|
| 0 | EDIT window |
| 1 | LIST window |
| 2 | OUTPUT window |
| 3 | COMMAND window |

By entering:

```
FULLW 2
```

the output window is set to the full available screen area. The other three windows are covered up by the output window.

## CLEARW

This command clears any of the four windows. It is comparable to the `CLS` command of Microsoft BASIC, but refers to a special window in ST BASIC. The command,

```
CLEARW 2
```

clears the output window. The position of the output cursor is not affected by this command, so the command `GOTOXY 0,0` should generally follow a `CLEARW 2` command. This places the cursor in the upper left corner.

## CLOSEW

Windows can be closed with the `CLOSEW` command. They then disappear from the screen completely. The numbers of the windows correspond to those in the other window instructions.

## OPENW

With this command, closed windows (`CLOSEW`) can be opened again. This command functions only when at least one other window is open. It appears to be an error in this version of ST BASIC.

## Summary

This brings us to the end of our description of the special commands of ST BASIC. The other commands and functions of ST BASIC are equivalent to those in other BASIC dialects. Since there is a great deal of literature covering the standard functions and commands, we will not go into them.

We have intentionally postponed a discussion of two special, very powerful commands. They are the `GEMSYS` and `VDISYS` commands. But since these commands are so complicated and powerful, we have set aside a special section for them. You will really be surprised by what you can do with them from ST BASIC.

## 1.2 BASIC and GEM

We've already seen some of the features that make ST BASIC a very complete implementation of the BASIC language. In addition, ST BASIC has commands that allow easy access to the powerful features of GEM.

GEM, the Graphics Environment Manager, is the visually-oriented user interface to the operating system. Rather than typing commands into the computer, the user can perform the equivalent of the command by manipulating "pictures" on the screen with the mouse.

GEM provides a comprehensive set of services for application programs. If an application is written to use these standard services, then it's possible to move that application to any computer that supports GEM.

How can this be possible? It's because the ST has a 68000 processor. The IBM PC uses an 8088 processor. GEM runs on both the ST and the IBM PC. If an application is written in a high-level language such as C to run on the IBM PC with GEM, then it need only be recompiled to run on the ST. In practice, small program changes are usually necessary, since hardware-specific aspects of the computer may creep into the application. But the concept of application portability is a very attractive feature of a GEM.

We'll now take a closer look at GEM by studying its two main components. These are the AES, or Application Environment Services, and the VDI, or Virtual Device Interface.

The AES manages the visual features that are characteristic of GEM applications: windows, pull-down menus, icons, etc. All of these are high-level and complex functions which are generally unsuitable for use from BASIC. There are exceptions, however, as we will see shortly.

The VDI provides the fundamental graphic primitives for displaying text and graphics or inputting data from the keyboard or mouse. The VDI is subdivided into the GDOS (Graphic Device Operating System) and the device drivers. Of particular importance is the device driver. This part of GEM is hardware-dependent and must be adapted for each output device. In the current release of GEM for the ST, the only available device driver is for the display monitor. Additional device drivers will certainly become available in time.

## 1.2.1 The VDISYS command

The VDI performs dozens of different functions. You can use the VDISYS command to access these functions from ST BASIC.

As part of the VDISYS command, several parameters are passed to GEM. The parameters consist of five arrays or memory areas in which values are stored. The arrays are named CONTRL, INTIN, INTOUT, PTSIN, PTSOUT. These names are reserved variable names is ST BASIC. Apparently the authors of ST BASIC found the features of the VDI so powerful that they reserved those variable names. The reserved variable names represent the address of the arrays, not the array itself. You can see the address of the arrays by entering:

```
? contrl;intin;intout,ptsin,ptsout
```

To be precise, the named arrays are not the actual arrays used by the VDI. Rather, the contents of the named arrays are transfered to the VDI.

Since ST BASIC makes it very convenient to access the array contents, using the VDI calls are simple. Here's an example:

```
POKE CONTRL   ,(command number)
POKE CONTRL+ 2,(number of parameters in ptsin)
POKE CONTRL+ 4,(number of parameters in ptsout)
POKE CONTRL+ 6,(number of parameters in intin)
POKE CONTRL+ 8,(number of parameters in intout)
POKE CONTRL+10,(sub-function command number)
POKE CONTRL+12,(device handle, between 1 and 10)
REM
POKE INTIN    ,(first parameter)
POKE INTIN + 2,(second parameter)
POKE INTIN + 4,(third parameter)
:
to
:
POKE INTIN + n,(last parameter)
REM
POKE PTSIN    ,(first parameter)
POKE PTSIN + 2,(second parameter)
POKE PTSIN + 4,(third parameter)
:
```

```
to
:
POKE PTSIN + n,(last parameter)
REM
VDISYS
REM
```

In this example, the individual parameters are POKEd into the corresponding array elements. Since the individual elements are all 16 bits wide, a single POKE places the value into the array element. This also explains the steps of two in the POKEs. The elements in the CONTRL array, CONTRL+4 and CONTRL+8 are not POKEd. After the call these these elements are PEEKed to determine how many parameters were returned in INTOUT and PTSOUT. The following example will make this clearer:

Normally, the mouse cursor is invisible. We can call the VDI to make it visible. As previously mentioned, the VDI performs many different functions. Each function is uniquely identified by a function code. The function code for enabling the mouse cursor is 122. For a complete list and in-depth description of these calls see the **GEM Programmer's Reference** from Abacus.

The name for function code 122 is SHOW MOUSE. We POKE the function code 122 into one element of the CONTRL array. SHOW MOUSE expects no parameters to be passed in the PTSIN array, so we POKE the value 0 into CONTRL+2. One parameter is expected in the INTIN array, so we POKE the value 1 into CONTRL+6. SHOW MOUSE does not have any subfunctions, so CONTRL+10 is set to zero.

CONTRL+12 contains the *device handle*. When ST BASIC is started, this element is set to a value of 2 to indicate the screen. Since any value between 1 and 10 is allowed for the device handle for output to the screen, you do not have to change this element. For a value between 11 and 20 output is sent to a plotter (if a suitable device driver were present). For a value between 21 and 30, the output is sent to a printer. These, then, are the values for the CONTRL array.

Now to the INTIN array. The counterpart to SHOW MOUSE is a function called HIDE MOUSE, which disables the mouse's cursor. When HIDE MOUSE is called, the VDI stores the number of HIDE MOUSE calls in an element of INTIN. If SHOW MOUSE is called with a value other than zero in INTIN, one is subtracted from the stored number. The cursor does not necessarily become visible after the call.

If INTIN has a value of zero, the number of HIDE MOUSE calls is ignored and the mouse cursor is enabled regardless.

The complete example looks like this:

```
1       rem 1_2_1
10      poke contrl,122
20      poke contrl+2,0
30      poke contrl+6,1
40      rem
50      poke intin,0
60      rem
70      vdisys
80      rem
```

After the call you'll find a value of zero in CONTRL+4 and CONTRL+8. This signals that the function has not returned any values in INTOUT or PTSOUT arrays.

## 1.2.2 Using VDI calls from BASIC

Most VDI calls can be used from ST BASIC. Some calls are unnecessary or superfluous since they have counter parts as BASIC commands. It's much more complicated to draw a line with VDISYS than with the LINEF command. Similarly, text output is simpler with PRINT than with VDISYS.

Try the examples that follow and decide for yourself whether you can make use of a given function.

First we'll look at some special effects with text.

## Text effects

VDI function 106 changes the appearance of the characters for text display. Here's an example:

```
10    rem 1_2a  text effects
100   fullw 2:clearw 2
110   a$    = "this is normal,      intin = "
120   a$(0) = "this is bold,        intin = "
130   a$(1) = "this is light,       intin = "
140   a$(2) = "this is italic,      intin = "
150   a$(3) = "this is underline,   intin = "
160   a$(4) = "this is outlined,    intin = "
170   gotoxy 6,3
180   ?a$;i
190   for i=0 to 4
200   gotoxy 6,5+2*i
210   poke contrl   ,106
220   poke contrl+ 2,0
230   poke contrl+6 ,1
240   poke intin    ,2^i
250   vdisys
260   ? a$(i);2^i
270   next
280   poke contrl   ,106
290   poke contrl+ 2,0
300   poke contrl+6 ,1
310   poke intin    ,0
320   vdisys
330   a=inp(2) : rem wait for keypress
```

This example demonstrates the different special effects. In addition, special effects may be mixed. For example, setting a value of 9 in INTIN produces "**bold/underlined**." In lines 280 to 320 the normal display mode is re-enabled by setting INTIN to zero. Unless you do this, all subsequent text is displayed with the special effects.

## Change character size

The size of the text can also be changed. A total of six character heights are possible. Since this also changes the character width, there are some problems outputting the three larger character heights.

The PRINT command assumes a character width of 8 pixels. Since the characters can be wider than 8 pixels, the right portion of the character is cut off. The three smaller character heights can be used without problems.

Here's an example of changing the character height:

```
1       rem 1_2_2b  change character height
10      fullw 2:clearw 2
20      a$(0) = "very small             , intin = "
30      a$(1) = "small                  , intin = "
40      a$(2) = "normal                 , intin = "
50      a$(3) = "large                  , intin = "
60      a$(4) = "larger                 , intin = "
70      a$(5) = "gigantic               , intin = "
80      a(0)=1:a(1)=9:a(2)=10:a(3)=16:a(4)=18:a(5)=20
90      gotoxy 6,3
100     for i=0 to 5
110     gotoxy 6,5+2*i
120     poke contrl   ,107
130     poke contrl+ 2,0
140     poke contrl+6 ,1
150     poke intin    ,a(i)
160     vdisys
170     ? a$(i);a(i)
180     next
190     poke contrl,107
200     poke contrl+ 2,0
210     poke contrl+6 ,1
220     poke intin,10
230     vdisys
240     a=inp(2) : rem wait for keypress
```

We can solve the character width problem through programming. More about this in our next example.

## Graphic Text Output

VDI function 8 outputs text. The string of text may contain special effects and may be used to correctly display enlarged characters that are only partially displayed with the PRINT command.

The text to be displayed is placed into the INTIN array. Each character of the text string occupies the lower byte of the array element (each is 2 bytes wide). In this example, the text string is placed into the array in lines 220 to 240. The last character of the text string **must** have a zero value, line 250.

The display location (on the screen) is passed through the PTSIN array. The display location are actual screen coordinates, not a relative location within the window. The VDI does not recognize windows; the AES manages them. The display location is relative to the upper-left corner of the character to be displayed. A value that positions some of the text off the screen should be avoided.
Here's the program:

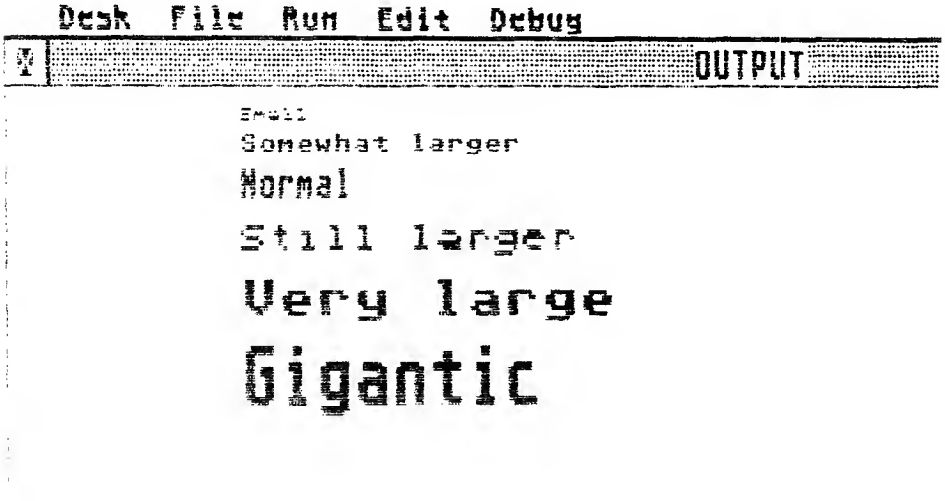
```
10    rem 1_2_2c  graphic text output
100   a$(0) = "small"
110   a$(1) = "somewhat larger"
120   a$(2) = "normal"
130   a$(3) = "still larger"
140   a$(4) = "very large"
150   a$(5) = "gigantic"
160   a(0)=1:a(1)=9:a(2)=10:a(3)=16:a(4)=18:a(5)=20
170   yp(0)=50:yp(1)=62:yp(2)=80:yp(3)=100:
      yp(4)=125:yp(5)=160
180   fullw 2:clearw 2
190   for c=0 to 5
200   a=a(c):a$=a$(c)
210   gosub setheight
220   for i=1 to len(a$(c))
230   poke intin+(i-1)*2,asc(mid$(a$(c),i,1))
240   next
250   poke intin+(i-1)*2,0
260   poke contrl   ,8
270   poke contrl+ 2,1
280   poke contrl+ 6,len(a$(c))+1
290   poke ptsin    ,100
300   poke ptsin+2  ,yp(c)
310   vdisys
```

```
320    next c
330    a=10
340    gosub setheight
350    a=inp(2) : rem wait for keypress
360    end
370    setheight:
380    poke contrl   ,107
390    poke contrl+ 2,0
400    poke contrl+6 ,1
410    poke intin    ,a
420    vdisys
430    return
```

Lines 210 and 370 illustrate another feature of ST BASIC: labels. You may use labels throughout a BASIC program. A label **must** be defined at the start of a line and be followed by a colon. Program text may follow the colon.

One of the nicest features of labels is that they are valid replacements for line numbers. So the commands GOTO, GOSUB, ON GOTO, ON GOSUB, and RESTORE may be used with labels. Line 340 shows such a replacement.

Line 350 waits for a keypress, which will end the program.



## Change direction of text output

You can change the angle of text output using VDI function 13. Only angle steps of 90 degrees may be specified, and these are given in units of tenths of a degree. A 90-degree angle is therefore specified as 900 units. The angle is passed to VDI function 13 through INTIN (line 320).

After you've displayed the text at the desired angle, you must set the angle back to zero, since all subsequent output is affected by the change.

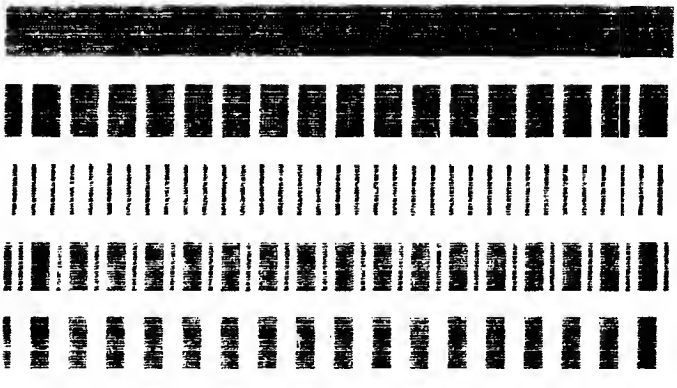
```
10    rem 1_2_2d  change direction of text output
100   a$ =" round and round"
110   fullw 2:clearw 2
120   for angle = 0 to 3
130   gosub txt.angle
140   for i=1 to len(a$)
150   poke intin+(i-1)*2,asc(mid$(a$,i,1))
160   next
170   poke intin+(i-1)*2,0
180   poke contrl   ,8
190   poke contrl+ 2,1
200   poke contrl+ 6,len(a$)+1
210   poke ptsin    ,300
220   poke ptsin+2  ,200
230   vdisys
240   next angle
250   a=inp(2) : rem wait for keypress
260   angle =0:gosub txt.angle
270   end
280   txt.angle:
290   poke contrl   ,13
300   poke contrl+ 2,0
310   poke contrl+6 ,1
320   poke intin    ,angle*900
330   vdisys
340   return
```

## Set line type

We've already mentioned that the characteristics of the drawing lines can be changed. VDI function 15 is used to set the line type. You can choose from among seven different line types by setting the parameter in INTIN. The following example displays the different line types available:

```
1       rem 1_2_2e  set line type
10      fullw 2:clearw 2
20      i=20
30      for pattern= 1 to 7
40      gosub set.pattern
50      for c=1 to 20
60      linef 20,c+i,500,c+i
70      next c
80      i=i+30
90      next pattern
100     a=inp(2) : rem wait for keypress
110     end
120     set.pattern:
130     poke contrl   ,15
140     poke contrl+ 2,0
150     poke contrl+ 6,1
160     poke intin    ,pattern
170     vdisys
180     return
```

In this program, all 7 line types are displayed, each 20 times. Line type 7 appears as a solid line, but can be changed to a user-defined line type. The next example shows you how to do this.

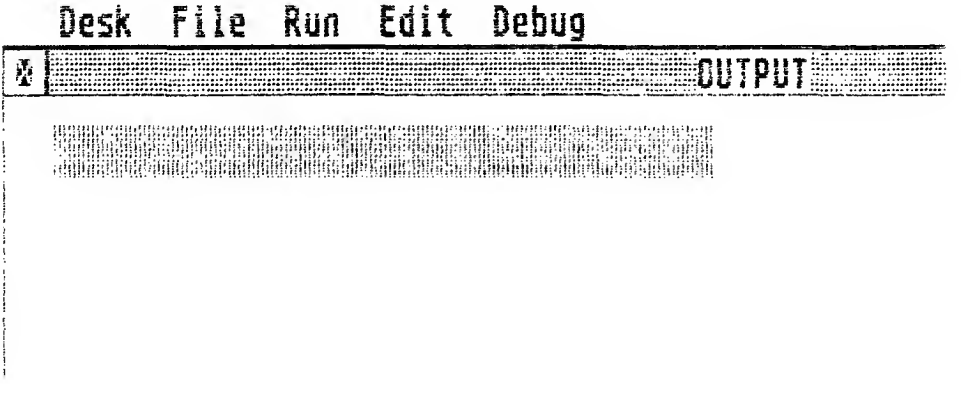


## Define line type 7

VDI function 113 is for defining line type 7. The bit pattern for the user-defined line type is stored in INTIN as a 16-bit word. The leftmost bit of the word corresponds to the leftmost pixel of the line segment.

```
10    rem 1_2_2f  define line type 7
100   fullw 2:clearw 2:i = 10
110   poke contrl   ,113
120   poke contrl+ 2,0
130   poke contrl+ 6,1
140   poke intin    ,&haaaa : ' pattern
150   vdisys
160   poke contrl   ,15
170   poke contrl+ 2,0
180   poke contrl+ 6,1
190   poke intin    ,7 : ' pattern
200   vdisys
210   for c=1 to 20
220   linef 20,c+i,500,c+i
230   next c
240   a=inp(2)
```

In this example we used a bit pattern %1010101010101010, which is equivalent to the hexadecimal number &hAAAA. Try defining your own line types. If the line is drawn vertically, note where the leftmost bit of the word appears.



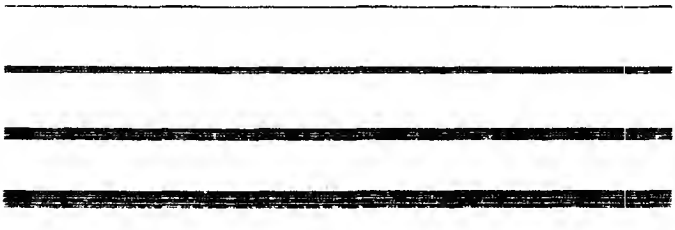
## Change line width

To vary the width of a line, you use VDI function 16. This saves you the trouble of using multiple LINEF or CIRCLE commands to make a thicker line.

The parameter representing the thickness is set in INTIN. Allowable values are the odd numbers beginning with 3. A value of 2 represents one pixel, the default value.

```
10    rem 1_2_g  change line width
100   fullw 2:clearw 2
110   i=20
120   linef 20,c+i,500,c+i
130   i=i+24
140   f = 3 to 25 step 2
150   gosub set.width
160   linef 20,  i,500,  i
170   i=i+25
180   next c
190   c=2:gosub set.width
200   a=inp(2): rem wait for keypress
210   end
220   set.width:
230   poke contrl   ,16
240   poke contrl+ 2,1
250   poke contrl+ 6,0
260   poke ptsin    ,c
270   poke ptsin + 2,0
280   vdisys
290   return
```

This program draws the different line thicknesses from 1 pixel to 25 pixels in width. You might want to call the last line a bar, since it's quite thick!



## Change appearance of end points

VDI function 108 sets the appearance of the endpoints of a line. If you have run the previous program, you can see that the endpoints of the line are cut off square. This is the standard setting for line representation.

But the end points can be drawn with rounded ends. For drafting or technical work, the lines can be drawn with arrowheads at the ends. It's a lot of work in BASIC, especially for the larger line thicknesses. But the VDI makes it much easier to do.

This function also works with the CIRCLE and ELLIPSE commands. You can change the sample program in such a way to draw a CIRCLE segment (arc) instead of a line (lines 140 and 180).

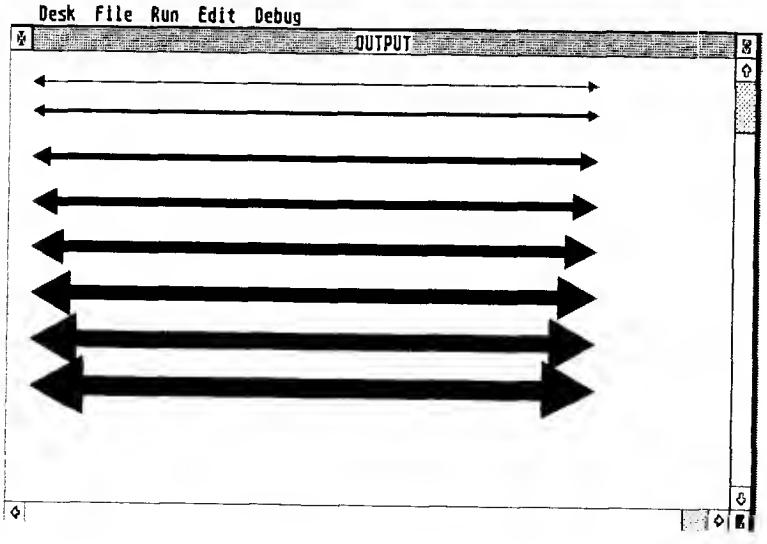
VDI function 108 requires parameters to specify the appearance of the starting and ending points of the line. These are passed in INTIN and INTIN+2. The values of 0, 1 and 2 are valid. A value of 0 is the default at power up. A value of 1 specifies that the starting or ending point is an arrowhead. A value of 2 specifies that the starting and ending point is rounded.

The following example is based on the one previous, for setting the line thickness. Therefore, you can just modify the previous program where needed and don't have to re-type the whole thing.

After one pass, a keypress (anything but <ESC>) is expected. The picture is then drawn with new end points. Pressing the <ESC> key ends the program and sets the parameters back to the power-up values.

```
10    rem 1_2_2h  rem end points
100   start = 0:fin =0
110   gosub set.end
120   i=20
130   fullw 2:clearw 2
140   linef 20,c+i,500,c+i
150   i=i+24
160   for c = 3 to 15 step 2
170   gosub set.width
180   linef 20,  i,500,  i
190   i=i+35
200   next c
210   c=2:gosub set.width
```

```
220   a=inp(2)
230   if a=27 then fin = 0:start = 0:
      gosub set.end:end
240   fin = fin +1
250   if fin = 3 then fin = 0:start = start +1
260   if start = 3 then start = 0
270   gosub set.end
280   goto 120
290   end
300   set.width:
310   poke contrl   ,16
320   poke contrl+ 2,1
330   poke contrl+ 6,0
340   poke ptsin    ,c
350   poke ptsin + 2,0
360   vdisys
370   return
380   set.end:
390   poke contrl   ,108
400   poke contrl+ 2,0
410   poke contrl+ 6,2
420   poke intin    ,start
430   poke intin + 2,fin
440   vdisys
450   return
```



## Reading the mouse position

You'll probably notice that there isn't a BASIC function for reading the position of the mouse. The VDI has a function for this: `124`. It also lets you know if any of the buttons are pressed. VDI function `124` requires no parameters.

The call to this function returns a value in `intin`. A value of 0 indicates that no buttons were pressed. A value of 2 indicates that the right button was pressed. A value of 3 indicates that both buttons were pressed.

The mouse position is returned in the `ptsout` array. The X-position is found at element `ptsout`. The Y-position is found at element `ptsout+2`. Both positions are the actual screen positions, not a position relative to a window.

The following program is more complex than earlier ones. The program is used to build a screen menu. We have several programming tricks so you should study the code closely.

When you run the program, a small menu is displayed. Using the mouse, you can point to the individual menu items and select them by clicking the mouse button. The first three selections are disabled in this example. But if you select the fourth, the program is ended.

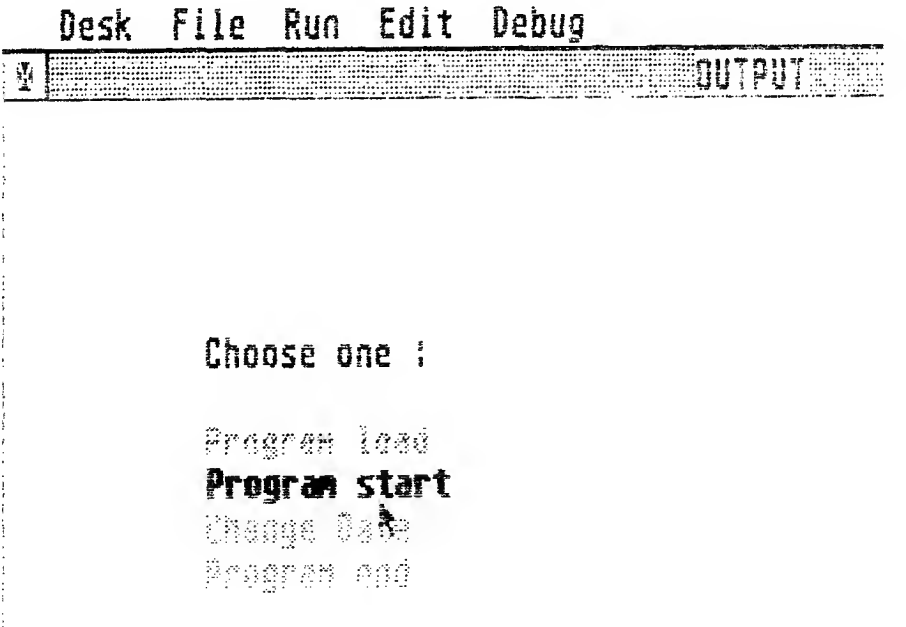
To emphasize which selection was clicked, it is displayed in bold while the others appear in fainter type (line 60). You can select the variables *active* or *inactive* according to your taste.

In this example, only the y-position of the mouse is needed to determine which menu item is selected. The value returned by the VDI is converted into an output line in line 110. To determine the y-position more easily, the REM command in line 110 should be removed. The y-position is then displayed in the upper lefthand corner for each change in the y-position.

```
1     rem 1_2_2i  read mouse position
10    a$(1)="Program load"
20    a$(2)="Program start"
30    a$(3)="Change Data"
40    a$(4)="Program end"
50    p(1)=7:p(2)=8:p(3)=9:p(4)=10
60    activ = 1 : inactiv = 2
70    fullw 2:clearw 2
```

```
80    gotoxy 5,5 : ? "Choose one :"
90    effect = inactiv : gosub text.effect :
      gosub 210
100   gosub mouse.button
110   outval = int((y.pos-108)/16) :
      rem gotoxy 1,1:?y.pos
120   gosub mouse.in : if button = 0 then 100
130   gosub mouse.out
140   if outval <1 or outval > 4 then 90
150   gosub 210
160   effect = activ : gosub text.effect
170   gotoxy 5,p(outval) : ? a$(outval)
180   if outval <> 4 then effect = inactiv
      else effect =0
190   gosub text.effect
200   if outval =  4 then select.ende else 100
210   for i=1 to 4
220   gotoxy 5,p(i) : ? a$(i)
230   next i
240   return
250   goto 100
260   '
270   mouse.in: rem ************************
280   poke contrl   ,122
290   poke contrl+2 ,0
300   poke contrl+6 ,1
310   poke intin    ,0
320   vdisys
330   return
340   '
350   mouse.out: rem ************************
360   poke contrl   ,123
370   poke contrl+2 ,0
380   poke contrl+6 ,0
390   vdisys
400   return
410   '
420   mouse.button: rem *********************
430   poke contrl   ,124
440   poke contrl+2 ,0
450   poke contrl+6 ,0
460   vdisys
470   button=peek(intout)
```

```
480   x.pos =peek(ptsout)
490   y.pos =peek(ptsout+2) - 38
500   return
510   '
520   text.effect: rem **********************
530   poke contrl   ,106
540   poke contrl+2 ,0
550   poke contrl+6 ,1
560   poke contrl+10,1
570   poke intin,effect
580   vdisys
590   return
999   '
1000  select.ende: rem ********************
1010  poke contrl,122
1020  poke contrl+2,0
1030  poke contrl+6,1
1040  rem
1050  poke intin,0
1060  rem
1070  vdisys
1080  end
```



## Set Writing mode

There are several *write modes* built into GEM. Normally, all output to the screen is done in *replace mode.*

In replace mode, if something is already displayed on the screen, any new text or output overwrites or replaces the old text or output.

In *transparent mode*, the background is not cleared when new text or output is displayed.

In the *XOR* mode, each pixel on the screen is reversed.

When you first run this program disable line 160 with a REM or its abbreviation ('). On a white background, there is no visible difference. Then when you run the program for the second time, enable line 160 by removing the REM. The results will clarify the different write modes.

```
0     rem 1_2_2j  set write mode
100    fullw 2:clearw 2:dim x$(4)
110    x$(1)="normal text,   replace mode"
120    x$(2)="text  in  transparent  mode"
130    x$(3)="text is  in  the  xor  mode"
140    x$(4)="text in reverse transparent"
150    color 1,1,1,2,2
160    fill 1,1 : rem out first run
170    for i=1 to 4
180    gosub set.wrt.mode
190    gotoxy 10,6+i: ?x$(i)
200    next
210    a=inp(2) : i=1
220    gosub set.wrt.mode
230    end
240    set.wrt.mode:
250    poke intin   ,i
260    poke contrl  ,32
270    poke contrl+2,0
280    poke contrl+6,1
290    vdisys
300    return
```

## 1.2.3 The GEMSYS command

The VDISYS call is used to access the functions of the Virtual Device Interface. As you'll recall, the other major portion of GEM is the Application Environment Services, AES. To access the AES, you use the GEMSYS command.

Parameters for this command are passed in various ways. These parameters may differ from those of the VDI. Also, the addresses of the parameter arrays are not readily available as with the VDISYS command. Instead, a table containing the address of the arrays is used. The table is accessed by the reserved variable name GB.

Table GB contains six addresses and is therefore 24 bytes long. The array names (used by Digital Research) are CONTROL, GLOBAL, INT.IN, INT.OUT, ADDR.IN and ADDR.OUT. We'll use these names in the following examples.

The CONTROL array works much like the CONTRL array in the VDISYS command. As a BASIC programmer, you need not concern yourself with this array because it's handled by a GEMSYS command in BASIC.

The second address in the GB table points to the GLOBAL array. This array contains various parameters which should not be changed. The values are also set by GEM.

The other four arrays function similarly to the VDISYS command. Note that each element of the INT.IN and INT.OUT arrays is two bytes in length (word), while the elements of the ADDR.IN and ADDR.OUT arrays are four bytes in length (long word).

The AES performs dozens of functions. Under BASIC, it's not possible to use all of these functions. For example, the keyboard and mouse operations are handled by interrupt routines. Routines for handling these may not be performed from ST BASIC. In most cases, the system will crash trying to handle such a request.

In order to make full use of the functions of the AES, you will have to use a language such as C, Pascal or Modula 2.

Despite the limitations, you can perform some AES functions from BASIC. This next example changes the name of the output window.

```
1      rem 1_2_3  name output window
10     gosub gem.arrays
20     x1=0:a$="This is our output window"
30     poke in  ,3
40     poke int.in+2,2
50     x1=varptr(a$)
60     poke int.in+4,x1 / 2^16
70     poke int.in+6,x1 and &hffff
80     poke int.in+8,0
90     poke int.in+10,0
100    gemsys 105
110    end
120    '
50000  gem.arrays:
50003  int.in    = peek(gb+8) *2^16 + peek(gb+10)
50007  return
```

In the subroutine `gem.arrays`, the address of the `int.in` array is found and stored in the variable of the same name in line 50003. The variable `x1` must be set up so as not to invalidate the result of the later `VARPTR` function. The text for the output window is contained in `a$`. You can put text of your choice here. But don't get too carried away or the text won't fit in the space provided. The length of the string shouldn't exceed 20 characters.

The parameters are then `POKE`d into the `int.in` array. The `GEMSYS` command does not differ from the `VDISYS` command in this respect. In lines 60 and 70 we pass the address of the string to the array. This address is found by the `VARPTR` function (line 50). If you don't completely understand this parameter-passing, you can refer back to the explanation of the `VARPTR` function in the previous section.

Interestingly, we don't `POKE` any values into the `CONTROL` array. We simply give `GEMSYS` the desired function number directly. ST BASIC calculates the values for the `CONTROL` array from this number and then places these into the array itself. This "luxury" would also be nice for `VDISYS`.

## 1.3 The speed of BASIC commands

Everyone is interested in how fast the ST will run in BASIC. But how are you to measure the execution speed? ST BASIC has no way of measuring time. Fortunately the problem can be solved relatively easily. The operating system contains an interrupt-controlled counter in memory locations $4BA to $4BD. The contents of these memory locations constitute a long word, a 32-bit value. The long-word value is incremented 200 times per second. Thus the resolution of the timer is 5 milliseconds. However, most commands are processed in a significantly shorter time. Therefore, to measure the duration of a command, you can execute the command many times in a loop and then divide the resulting time by the number of passes. After subtracting the time for the FOR...NEXT loop, you'll have an accurate time for the execution of the command.

We determined the execution time of many commands with the following short program:

```
10     rem 1_3  measure execution time of cmd in 130
100    timer = &h4bc
110    time1 = peek(timer)
120    for i = 1 to 10000
130    let a = 1
140    next i
150    time2 = peek(timer)
160    time  = time2 - time1
170    time  = (time*5/10000)-.8495
180    ? "the command in 130 requires"time
       "milliseconds"
```

On the average, all ST BASIC commands require between about 0.6 and 1.9 milliseconds. The slowest is the PRINT command. The time to output a single character is about 4.5 milliseconds. The exact duration of a PRINT is not so easy to calculate. We did this by determining the time for the GOTOXY command and noting it. We then determined the time for the line:

```
130 gotoxy 0,0:PRINT "a";
```

and subtracted the time for the GOTOXY. Note the semicolon at the end of the PRINT output. Without the semicolon the characters CR and LF would be printed after the "a".

The times increase dramatically if we remove the GOTOXY command and the semicolon. Then the screen scrolls on (almost) every output. If you really want to find out the time required for this, you should reduce the number of passes to 100 or 200 (lines 120 and 170). Otherwise the test run is very time-consuming.

The most interesting results are from the floating-point functions like SQR, SIN, and LOG. These functions are very fast. If we compare the times determined with those from other computers, we see an enormous increase in speed. The time for the SQR function on a Commodore 64 is about 54 milliseconds. On the ST the function requires only about 1 millisecond!

The surprising differences of times, compared to the other functions, is brought about because much of BASIC is written in C. Only the floating-point functions are written in assembly language. Floating-point routines were written by Motorola, the developer of the 68000.

## 1.4 BASIC and machine language

Do you have a need to mix BASIC and machine language? Most functions are available directly from BASIC. But it's the word *most* that made us decide to investigate further. Recall that the clock time is unavailable from BASIC. Yet the operating system has an accurate clock that runs in two-second steps. Here's a way to use the clock from BASIC.

### 1.4.1 "SAFE" places for machine language programs

We decided to write a machine language program for using the clock. But first we are faced with another problem. How do we combine a machine language program and a BASIC program and avoid problems?

The simplest solution is to place the machine language routine in an area of memory that's safe from BASIC. One choice is the "free" area above the screen memory. Screen RAM is organized to use the upper 32K of memory. On the 520ST, screen RAM is located at $78000. On the 1040ST, it is located at $F8000. The screen occupies 640 x 400 = 32,000 bytes. The remaining 768 bytes of the 32K area (32K = 32,768) is not used by the operating system. Assuming that it is small enough to fit, a machine language program can be `POKE`d into this area.

A program that uses this area must determine if the computer has 512K or 1024K and select the corresponding address. When a "free" area like this exists, many programs may want to use this memory for routines. If two programs try to use the same area simultaneously, then there's a good chance that there will be serious problems.

So where should machine language routines be located? One trick is to pack the machine language routine into a string variable. BASIC does not care if a variable `A$` contains text like `"Hi there everybody"` or a machine language program. We'll demonstrate how you can transfer machine code to a string variable shortly.

To read the clock from a machine language program, you use the `TRAP #1` instruction with a value of $2C on the stack. This call to the operating system returns the time in the D0 register. The value in D0 is coded in individual bits. To determine the time, you must decode the bits.

Here's the routine to read the clock:

```
000000  move.l   a0,a5          address of routine to a5
000002  move.w   #$2c,-(a7)     get function number clock time
000004  trap     #1             execute function
000008  addq.l   #6,a7          repair stack pointer
00000a  move.w   d0,$10(a5)     write clock time in memory
00000e  rts
000010  ds.w     1              space for time
```

If you assemble this routine and call it from BASIC using the CALL command, the address of the routine is found in register A0. The first instruction transfers the routine address to register A5—we'll need it later. Next the clock time is determined by calling the operating system using the TRAP #1 instruction. Then the stack pointer is restored to its original value. The time is returned in register D0, which is saved in memory. Register A5 is used to access this "save area," which is 16 bytes ($10) from the start of the routine.

By assembling this routine, you'll get the opcodes for the machine language instructions. Here are the opcodes for the routine above:

```
$2a,$48,$3f,$3c,$00,$2c,$4e,$41
$54,$8f,$3b,$40,$00,$10,$4e,$75
```

The next step is to get these values into a string variable. We can use the following BASIC statements to do this:

```
1     rem 1_4_1a  m/l in string
10    for i=0 to 17
20    read byte
30    clk$=clk$+chr$(byte)
40    next
50    data &h2a,&h48,&h3f,&h3c,&h00,&h2c,&h4e,&h41
60    data &h54,&h8f,&h3b,&h40,&h00,&h10,&h4e,&h75
70    data &hff,&hff
```

The last two values represent the area to store the clock time. If you do not reserve the area within the string variable, you will overwrite another variable stored in memory.

We've written the machine language routine and stored it in a "safe" place in memory. Now we must find a way to execute the routine.

To do this, we must know the address at which the string is stored. You may recall that the VARPTR may be used to determine the address of a string descriptor. In bytes 3 through 6 the descriptor is the address of the actual string. This is also the address of our machine language routine, of course.

```
80 addr = 0
90 addr = varptr(clk$)
```

The VARPTR function returns an address into the variable addr.

Line 80 is important, by the way. If the variable addr is not initialized, the results can be corrupted by initialization during the VARPTR function.

Now we call the machine language program to read the clock time. We use the CALL command.

```
100 call addr
```

After this command, the clock time is found in the rightmost two characters of the string variable clk$. You can access these "characters" using the RIGHT$ and LEFT$ function.

```
110 time$ = right$(clk$,2)
120 sec=(asc(right$(time$,1))+
    asc(left$(time$,1))*256)*2
125 print "Total seconds since 12:00 AM " sec
130 goto 100
```

This method of calling a machine language routine from BASIC has its drawbacks. A string variable is limited to 256-characters in length. Therefore the length of the machine language routine is limited too. Passing parameters through individual strings can be complicated. So we came up with alternative way to combine machine language and BASIC.

This method is the most flexible option for combining machine language programs in BASIC programs. The routine is placed in an integer array.

If you examine the structure of an integer array you will see that the individual elements of the array are located one after the other in memory. The element with the lowest index lies at the lowest address. Each element is two bytes in length—just right for the opcodes of the 68000. The size of a machine language program in an array is not as severely limited as it is with the string method. Programs can easily be 1000 bytes or longer.

```
1       rem 1_4_1b  m/l in integer array
10      dim clk%(8)
20      for i=0 to 8
30      read clk%(i)
40      next i
50      data &h2a48,&h3f3c,&h002c,&h4e41,&h548f
60      data &h3b40,&h0010,&h4e75,&h0000
```

As you see, we first dimension the array (line 10) and then place the program in it. This initialization is shorter than with the previous program because the data elements are now 16 bits each.

Once again we must determine the address of the routine by using the VARPTR function. The result of the VARPTR points directly to the first command of the routine. Therefore we can use the result as the jump address for the CALL command!

```
70    ad = 0
80    ad = varptr (clk%(0))
90    call ad
```

We can also get the result easily. It is contained in array element clk%(8).

```
100   ?clk%(8)
```

Parameters can also be passed to the routine in the same way. You simply enter the parameters into the appropriate array elements and the program fetches them from the selected memory locations.

## 1.5 The most expensive clock in your house

Some people might consider this program to be rather useless. We disagree, because the program demonstrates some fundamental programming techniques.

We have used several graphics capabilities of the ST in the following program with a short routine for reading the clock time. The following is a short description of some of the special features of the program:

Several variables are initialized in the first seven lines of the program.

Variable `h0` is the size of the type for the digital display. If you stop the program, the ST will not automatically switch back to the normal type size. This is especially annoying during a test run when you've made a typing error in the program. For the test run, set this variable to a value of 10. This will set the type to its normal size.

Variables `xm%` and `ym%` determine the center of the dial.

Variables `sec.p%, min.p%, hrs.p%` determine the length of the three pointers.

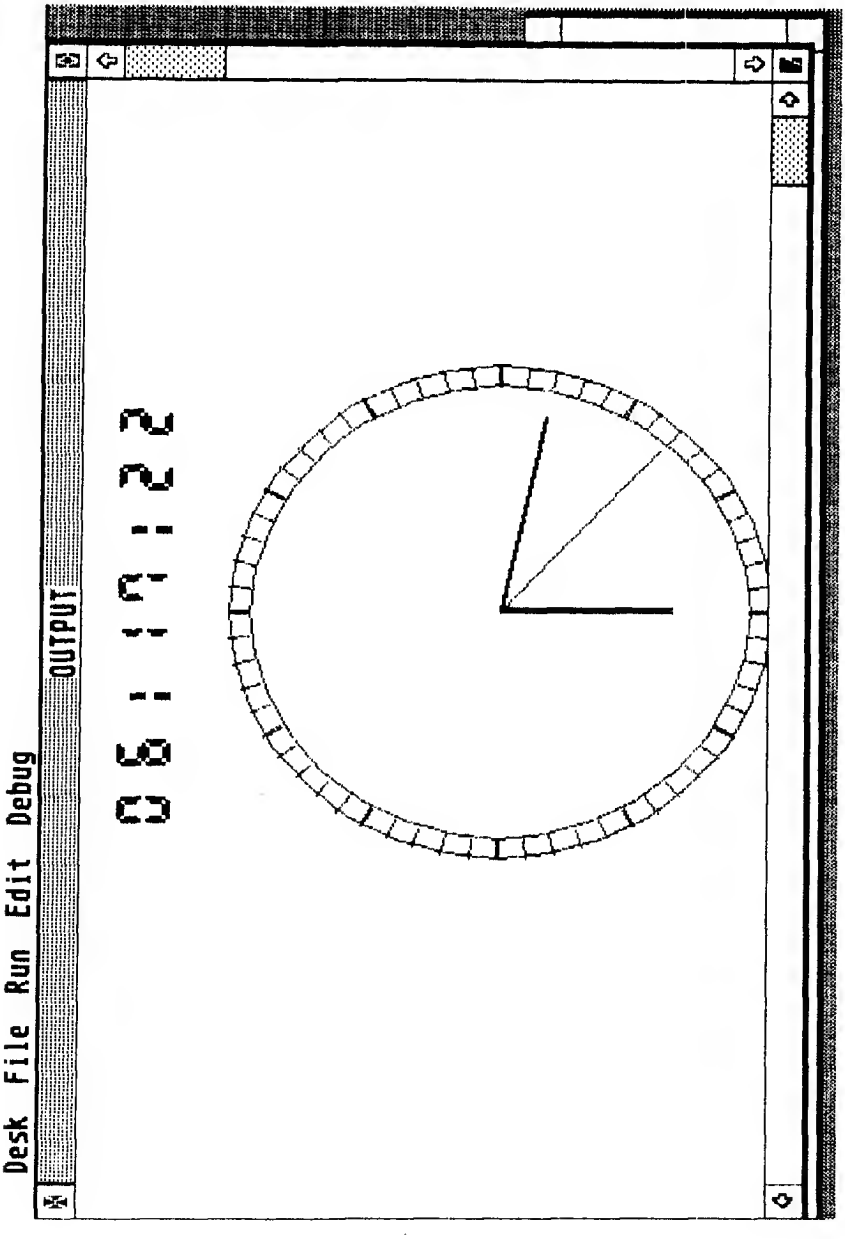
Variable `pi` is the value π (3.14159), which is not directly available in ST BASIC.

Next, the type height is set, the array for the machine language program is set , and the dial is drawn.

The actual program begins in line 1130. Line 1135 checks for the mouse button. If a button is pressed, the character size is returned to normal. The machine language program places the seconds in `clk%(20)`, the minutes in `clk%(21)`, and the hours in `clk%(22)`. After this, a comparison is made to see if the new value for the seconds is the same as the old value. As long as this is the case, a new pass through the loop is made. Not until the seconds have changed is the loop exitted.

The remainder of the program is relatively easy. You should have no trouble understanding it.

Figure 1.4-1



```
100   rem clock
1000  h0=25
1010  dim clock%(23)
1020  xm% = 320:ym% = 200
1030  sec.z% = 115 : min.z% =105 : std.z% = 80
1040  pi=4*atn(1)
1050  g89 = 89.9*(pi/180) : g90 = pi/2 : g91 = 90.1*(pi/180)
1060  clock  = 0
1070  '
1080  fullw 2:clearw 2
1090  gosub height
1100  gosub init.clock
1110  gosub clockface
1120  '
1130  loop: '   *************************
1135  gosub mouse.button
1140  clock = varptr (clock%(0))
1150  call clock
1160  if sec% = clock%(20)*2 then loop
1170  '
1180  ' erase hands ******************
1190  sec% = clock%(20)*2
1200  color 0,0,0,0,0
1210  dmy% = std% : std% = clock%(22)
1220  if dmy%<> std% then phi = phistd :r%=std.z%:gosub draw
1230  dmy% = min% : min% = clock%(21)
1240  if dmy%<> min% then phi = phimin :r%=min.z%:gosub draw
1250  phi = phisec : r%=sec.z%: gosub draw
1260  '
1270  '
1280  ' draw new hands ************
1290  color 1,0,1,1,1
1300  phisec = sec%*pi/30-g90: r%=sec.z%
1310  phi = phisec : gosub draw
1320  phimin = min%* 6 * (pi/180)-g90 : r%=min.z%
1330  phi = phimin : gosub draw
1340  phistd = std%* 30 * (pi/180)-g90 : r%=std.z%
1350  phi = phistd : gosub draw
1360  gosub digital
1370  goto loop
1380  '
1390  draw:   ' ***********************
1400  linef xm%  ,ym%  ,xm%+r%*cos(phi)  ,ym%+r%*sin(phi)
```

```
1410  if r%= sec.z% then return
1420  '
1430  linef xm%+1,ym%  ,xm%+r%*cos(phi)+1,ym%+r%*sin(phi)
1440  linef xm%  ,ym%+1,xm%+r%*cos(phi)  ,ym%+r%*sin(phi)+1
1450  linef xm%+1,ym%+1,xm%+r%*cos(phi)+1,ym%+r%*sin(phi)+1
1460  if r%= min.z%then return
1470  '
1480  linef xm%+2,ym%  ,xm%+r%*cos(phi)+2,ym%+r%*sin(phi)
1490  linef xm%  ,ym%+2,xm%+r%*cos(phi)  ,ym%+r%*sin(phi)+2
1500  linef xm%+2,ym%+2,xm%+r%*cos(phi)+2,ym%+r%*sin(phi)+2
1510  return
1520  '
1530  clockface:  '********************
1540  circle xm%,ym%,120,120
1550  circle xm%,ym%,130,130
1560  for std%= 1 to 12
1570  phi = std%* 30 * (pi/180)-g90 : r1%=130 : r0%=120
1580  linef xm%+r0%*cos(phi),ym%+r0%*sin(phi),
      xm%+r1%*cos(phi),ym%+r1%*sin(phi)
1590  phi = std%* 30 * (pi/180)-g89 : r1%=130 : r0%=120
1600  linef xm%+r0%*cos(phi),ym%+r0%*sin(phi),
      xm%+r1%*cos(phi),ym%+r1%*sin(phi)
1610  phi = std%* 30 * (pi/180)-g91 : r1%=130 : r0%=120
1620  linef xm%+r0%*cos(phi),ym%+r0%*sin(phi),
      xm%+r1%*cos(phi),ym%+r1%*sin(phi)
1630  next std%
1640  for min%= 1 to 59
1650  phi = min%* (pi/30) : r1%=130 : r0%=120
1660  linef xm%+r0%*cos(phi),ym%+r0%*sin(phi),
      xm%+r1%*cos(phi),ym%+r1%*sin(phi)
1670  next min%
1680  return
1690  '
1700  digital: ' ************************
1710  sec$=str$(sec%): if len(sec$)=2 then
      sec$=" 0"+right$(sec$,1)
1720  min$=str$(min%): if len(min$)=2 then
      min$=" 0"+right$(min$,1)
1730  std$=str$(std%): if len(std$)=2 then
      std$=" 0"+right$(std$,1)
1740  timdig$=right$(std$,2)+"Z"+right$(min$,2)+"Z"+
      right$(sec$,2)
1750  gosub printdig
```

```
1760  return
1770  '
1780  height:    ' ************************
1790  poke contrl   ,107
1800  poke contrl+2,0
1810  poke contrl+6 ,1
1820  poke intin,h0
1830  vdisys
1840  return
1850  '
1860  printdig: rem **********************
1870  poke contrl   ,11
1880  poke contrl+2 ,2
1890  poke contrl+6 ,10
1900  poke contrl+10,10
1910  poke contrl+12,2
1920  poke intin    ,1
1930  poke intin+2  ,1
1940  for i%=1 to 8
1950  poke intin + (i%*2+2),asc(mid$(timdig$,i%,1))-32
1960  next i%
1970  poke ptsin,210
1980  poke ptsin+2,80
1990  poke ptsin+4,220
2000  poke ptsin+6,0
2010  vdisys
2020  return
2030  '
2040  init.clock:    ' **********************
2050  data &h2a48,&h3f3c,&h002c,&h4e41,&h548f,&h3b40,&h0028
2060  data &h026d,&h001f,&h0028,&hea48,&h3200,&h0240,&h003f
2070  data &h3b40,&h002a &hec49,&h3b41,&h002c,&h4e75
2075  data &h0000,&h0000,&h0000,&h0000
2080  for i% = 0 to 23
2090  read clock%(i%)
2100  next i%
2110  return
2120  mouse.button: ' ****
2130  poke contrl,124: poke contrl+2,0: poke contrl+4,0
2160  vdisys
2170  button = peek(intout)
2180  if button <> 0 then h0=10: gosub height: end
2190  return
```

## 1.6 Automatic hardcopy

To get a hardcopy of the screen, you can press the <ALT> and <HELP> keys simultaneously. Memory location 1262 is a flag that tells the ST to print a screen hardcopy. Normally the memory location has a value of -1. Pressing <ALT> <HELP> increments the value and generates the hardcopy.

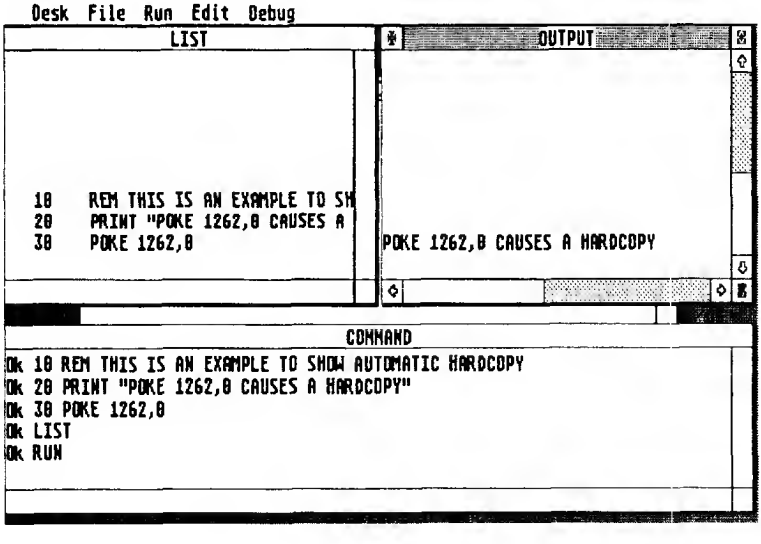
Knowing this, you can POKE memory location 1262 to get "automatic" hardcopy:

```
poke 1262,0
```

Alternatively, you can issue a VDI function 5 to perform hardcopy as follows:

```
contrl   ,5
contrl+ 2,0
contrl+ 6,0
contrl+10,17
```

By the way, the hardcopy can be interrupted by pressing <ALT> <HELP> while it's printing.



# CHAPTER 2

## Utilities for the ST

## Utilities for the ST

This chapter contains a very powerful set of utility programs. These are mostly machine language programs that change or extend the functions of the operating system. All are memory-resident, and will make it easier to work with the ST and other applications.

Each utility is preceded by a brief description of the program, its application and its capabilities. The source code for each program is written in 68000 assembly language.

Each is documented so that you can makes changes or enhancements according to your needs. But to do so, you'll require an assembler.

If you program only in BASIC, you can use the BASIC loader to create the program. A BASIC loader contains the machine language utility in the form of `DATA` statements. The BASIC loader uses a checksum to insure that input errors are eliminated. By running the BASIC loader, you create a program file on the disk that's normally created by the assembler and linker. Once you've run the BASIC loader for each utility, you can then start each of them by clicking the appropriate icon with the mouse.

## 2.1 Current time display

In the following utility we'll show you three programming techniques to use in your own programs. The first technique lets you execute a program periodically. The second technique shows you where in memory to place a short program so it's not destroyed later by other programs. The third technique shows you how to use the ST's system fonts.

This utility creates a digital clock in the upper righthand corner of the screen. It's displayed whenever you are working on the desktop or with GEM programs. In both of these cases, the top line of the screen is a status line and the last 10 characters are normally unused.

To work correctly, the clock time is continually redisplayed. To do this we use the ST's vertical blank interrupt (VBL). The VBL is called each time the computer has completed displaying a complete video picture. This happens 70 times a second with the monochrome monitor.

The VBL routine checks a jump table containing the addresses of user routines to be executed during the VBL. The table normally has 8 entries. A zero value indicates that the entry is not used. To execute a user routine, you must search the table and place the address of your routine into the first unused entry. From then on, this routine is executed 70 times per second during a VBL interrupt.

Now we have to find a place for the program itself. In order to explain the program, we'll repeat part of an earlier chapter.

If the program is smaller than 3 full pages (768 bytes), you can place the program above screen memory. After power-up the ST reserves the top 32K of memory for the screen display. On the 520 ST the screen occupies $78000 to $7FFFF.

You'll recall that the screen is a maximum of 640x400 pixels, which equates to 256,000 bits, or 32,000 bytes. A 32K area contains 32,768 bytes, so the last 768 bytes of screen memory are "left over." Screen memory occupies only the area from $78000 to $7FCFF, inclusive. The memory from $7FD00 to $7FFFF is not used for screen output. So this area can be used for a short routine.

To install the utility, an initialization routine must copy the program to this memory area and then set the VBL vector to point to this address.

The VBL table is part of the system variables. To access a system variable, the ST must be in the supervisor mode. Then we need to find an unused entry in the VBL list, save the address of this entry in register A2 and copy our utility to its proper location. The length of the utility is a counter. The destination address is the length of the utility *plus* 32000, the length of the screen. Now we can copy the utility to the top of the screen memory. Then we call the routine to initialize the time display and finally set the VBL vector to our routine and return to the desktop.

The `init` routine returns a pointer to the font which we will use to display the time. To do this we use a special part of TOS (*line A routine*) that returns a pointer to a vector array of the three system fonts in register A1. Next we get the address of the second font, the 8x16 pixel font which is the standard for monochrome display. We set the VBL counter to 1 which will start our routine after the next VBL.

A counter is used because we don't have to display the time 70 times a second. We decrement the counter each time through the routine and update the display only when the counter is zero. The display routine resets the counter. This routines gets the clock time from the processor and is identical to the corresponding BIOS function which returns the time in DOS format with a resolution of 2 seconds. The keyboard processor however keeps time exactly to the second in BCD format. This time is saved by the ST at address $A46 at the label `time` in the program listing. The three bytes, the hour, the minute and the second are in the 24-hour format but are written to the screen by the routine `wrtbcd`.

The routine `wrtchar` writes a character contained in register D0 to the top line of the screen. The cursor position is contained in the register D6 (a value between 0 and 79). The current position within the screen memory is determined from the cursor position and the base address of the screen memory. Then the address of the point, the offset of the next raster line, the number of scan lines and the height of the character are determined from the font header. In the routine at label `loop`, the data from the font definitions is copied to the screen, raster line by raster line, until an entire character is written. The program will work on a monochrome monitor without changes.

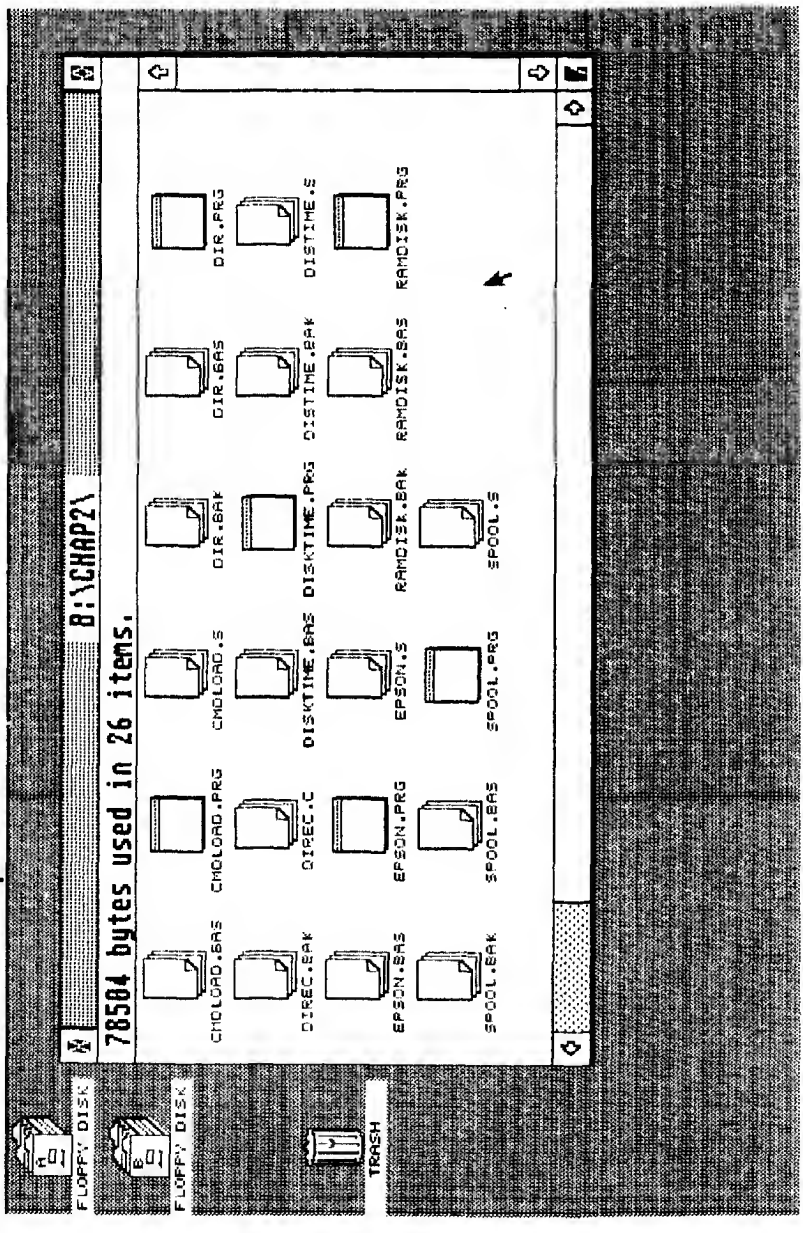
Why didn't we write the characters to the screen with the BIOS or GEMDOS routine? Why did we copy the system font data to the screen memory? The answer is that we are working within an interrupt routine. Using the BIOS or GEMDOS routines, a screen output can be interrupted and the cursor may be moved to a different position on the screen. To avoid

this, we would have to save the cursor position, set the cursor to the top line, write the character to the screen and then set the cursor to its original position. If another font were being used, then our display time would become confused. By accessing the system fonts directly, we avoid these problems and perform the work at faster speeds.

Figure 2.1 shows the time display in the status line of the desktop.

Following is the assembly language listing of the program. If you do not have an assembler, the short BASIC program will create an equivalent machine language program to display the time. Running the BASIC loader creates a program file called `TIME.PRG`. You can start it as usual by clicking its icon.

Figure 2.1


Desk File View Options
06:10:55
B:\CHAP2\
78584 bytes used in 26 items.
FLOPPY DISK
FLOPPY DISK
TRASH
CMDLOAD.BAS
CMDLOAD.PRG
DIREC.C
DISKTIME.BAS
EPSON.S
SPOOL.PRG
SPOOL.S
DIR.BAS
DISTIME.S
RAMDISK.PRG

```
*    display current time
*    use vertical blank interrupt
*
*    LE 2/8/85
*

_v_bas_ad  equ   $44e    screen address
hz_200     equ   $4ba    200hz system timer

gemdos     equ   1
setexec    equ   5
bios       equ   13
keep       equ   $31
gettime    equ   23
super      equ   38    execute in supervisor mode
xbios      equ   14

           move.l    4(sp),a0          calculate program
size
           move.l    #$100,d6
           add.l     12(a0),d6
           add.l     20(a0),d6
           add.l     28(a0),d6

           bsr       init              program init.

           clr       -(sp)
           move.l    d6,-(sp)          number bytes
           move      #keep,-(sp)
           trap      #gemdos


init       dc.w      linea
           moveq     #2*4,d0           font number
           lea       fontptr(pc),a3
           move.l    (a1,d0),(a3)      mark font pointer

           move      #gettime,-(sp)
           trap      #xbios
           addq.l    #2,sp
           move      d0,d7

           pea       sup_rout(pc)
```

```
        move    #super,-(sp)    execute rest in *
*                               supervisor mode
        trap    #xbios
        addq.l  #6,sp
        rts

sup_rout:
        move    d0,d7
        and     #%11111,d0
        lsl     #1,d0           seconds in binary
        move    d0,second

        move    d0,d7
        lsr     #5,d0
        and     #%111111,d0
        move    d0,minute

        move    d7,d0
        moveq   #11,d1
        lsr     d1,d0
        move    d0,hour

        move    #$2700,sr       interrupts disabled

        move.l  hz_200,time
        add.l   #200,time

        pea     hz_int(pc)
        move    #$45,-(sp)      timer c interrupt
*                               vector
        move    #setexec,-(sp)
        trap    #bios
        addq.l  #8,sp
        move.l  d0,hz_save      200hz vector mark
        rts

hz_int  movem.l d0-d7/a0-a6,-(sp)     save regs

        move.l  time,d0
        cmp.l   hz_200,d0       one second yet?
        bne     no_show         no

        add.l   #200,time       next second
```

```
        addq    #1,second
        cmp     #60,second      check seconds
        bne     show_time
        clr     second
        addq    #1,minute       next minute
        cmp     #60,minute      check minutes
        bne     show_time
        clr     minute
        addq    #1,hour
        cmp     #24,hour        check hours
        bne     show_time
        clr     hour

show_time:

        moveq   #70,d6          cursor position

        move    hour,d0         get hour
        bsr     wrtdec
        bsr     wrtcol

        move    minute,d0       get minute
        bsr     wrtdec
        bsr     wrtcol

        move    second,d0       get second
        bsr     wrtdec

no_show movem.l (sp)+,d0-d7/a0-a6
        move.l  hz_save,-(sp)   address of routine
        rts

wrtdec:
        move    #$2f,d1         number 10
wrtdec1 addq    #1,d1
        sub     #10,d0
        bpl     wrtdec1
        add     #$3a,d0         one digit
        move    d0,-(sp)
        move    d1,d0
        bsr     wrtchar         output
        move    (sp)+,d0        unit
        bra     wrtchar         output
```

```
wrtcol  moveq   #$3a,d0          ':'

*
*    system font ATARI ST
*    LE 9/8/85
*

adelow     equ   36    lowest ascii-code in font
adehigh    equ   38    highest ascii-code in font
cellwd     equ   52    linewidth
fontdat    equ   76    ptr to font data
formwd     equ   80    status of next raster line in
*                      font
formhg     equ   82    number of raster lines / char

linea      equ   $a000

line1      equ   80    bytes per screen line

*        write character to to graphic ram
*        d0 = character
*        d6 = cursor column
*
wrtchar:
         moveq   #0,d1
         move    d6,d1
         addq    #1,d6              move cursor to next
*                                   column
         move.l  fontptr(pc),a3     get font pointer
         add.l   _v_bas_ad,d1       plus screen address
         move.l  d1,a4
         move.l  fontdat(a3),a0     font data pointer
         move    formwd(a3),d2      offset of next
*                                   raster line in font
         move    formhg(a3),d7      form height (number
*                                   pf scan lines)
         subq    #1,d7

loop     move.b  (a0,d0),(a4)       onscreen raster
*                                   line
         add     #line1,a4          pointer to next
```

```
*                                       screen line
        add     d2,a0                   pointer to next
*                                       raster line in font
        dbra    d7,loop
        rts


fontptr ds.l     1
hz_save ds.l     1
second  ds.w     1
minute  ds.w     1
hour    ds.w     1
time    ds.l     1
```

## BASIC loader for display time

```
100   open "R",1,"b:time.prg",16: rem disk b
110   field#1,16 as bin$
120   a$="": for i=1 to 16: read x$: if x$="*"then 150
130   a=val("&H"+x$): s=s+a:a$=a$+chr$(a): next
140   lset bin$=a$: rec=rec+1: put 1,rec: goto 120
150   data 60,1A,00,00,01,82,00,00,00,00,00,00,00,00,00
160   data 00,00,00,00,00,00,00,00,00,00,00,00,20,6F,00,04
170   data 2C,3C,00,00,01,00,DC,A8,00,0C,DC,A8,00,14,DC,A8
180   data 00,1C,61,0A,42,67,2F,06,3F,3C,00,31,4E,41,A0,00
190   data 70,08,47,FA,01,48,26,B1,00,00,3F,3C,00,17,4E,4E
200   data 54,8F,3E,00,48,7A,00,0C,3F,3C,00,26,4E,4E,5C,8F
210   data 4E,75,30,07,C0,7C,00,1F,E3,48,33,C0,00,00,01,78
220   data 30,07,EA,48,C0,7C,00,3F,33,C0,00,00,01,7A,30,07
230   data 72,0B,E2,68,33,C0,00,00,01,7C,46,FC,27,00,23,F9
240   data 00,00,04,BA,00,00,01,7E,06,B9,00,00,00,C8,00,00
250   data 01,7E,48,7A,00,16,3F,3C,00,45,3F,3C,00,05,4E,4D
260   data 50,8F,23,C0,00,00,01,74,4E,75,48,E7,FF,FE,20,39
270   data 00,00,01,7E,B0,B9,00,00,04,BA,66,6A,06,B9,00,00
280   data 00,C8,00,00,01,7E,52,79,00,00,01,78,0C,79,00,3C
290   data 00,00,01,78,66,32,42,79,00,00,01,78,52,79,00,00
300   data 01,7A,0C,79,00,3C,00,00,01,7A,66,1C,42,79,00,00
310   data 01,7A,52,79,00,00,01,7C,0C,79,00,18,00,00,01,7C
320   data 66,06,42,79,00,00,01,7C,7C,46,30,39,00,00,01,7C
330   data 61,20,61,36,30,39,00,00,01,7A,61,16,61,2C,30,39
340   data 00,00,01,78,61,0C,4C,DF,7F,FF,2F,39,00,00,01,74
350   data 4E,75,72,2F,52,41,90,7C,00,0A,6A,F8,D0,7C,00,3A
360   data 3F,00,30,01,61,06,30,1F,60,02,70,3A,72,00,32,06
370   data 52,46,26,7A,00,28,D2,B9,00,00,04,4E,28,41,20,6B
380   data 00,4C,34,2B,00,50,3E,2B,00,52,53,47,18,B0,00,00
390   data D8,FC,00,50,D0,C2,51,CF,FF,F4,4E,75,00,00,00,00
400   data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
410   data 00,50,0E,0C,0E,0A,16,0C,12,06,08,08,06,08,08,06
420   data 08,08,08,0a,0a,0c,00,00,00,00,00,00,00,00,00,00
430   data *
440   close 1:if s<> 25074 then ? "ERROR in DATA !!": end
450   print "Ok."
```

## 2.2 Print spooler for the ST

Have you ever sat in front of your computer and waited for a 10-page listing to print? While waiting, you could be doing other work on the computer. Here's a very useful utility to cut the time spent waiting for lengthy printouts.

The speed of a printer depends on the printer mechanism, which is usually much slower that the rate at which the computer sends data to the printer. Because of this speed discrepancy, some printers contain a buffer that holds data temporarily as it arrives from the computer. The data is retrieved from the buffer as the print mechanism is ready to print it.

A typical size for a buffer is 2K—roughly one page of text. If the document to be printed is larger than 2K, the buffer fills up and the computer stops sending data to the printer until the buffer can accept more data. One way to avoid this computer-waiting-for-data problem is to install a larger print buffer. Unfortunately, these are rather expensive. But we have a computer with 512K or 1024K of memory. Why not put the print buffer in the ST itself?

Enter the print spooler. To better understand this utility program, we'll briefly describe how data is transferred from the computer to the printer.

Data is transferred one byte at a time over a Centronics interface. So that the computer and the printer can agree on the time of the transfer, two *handshake lines* are used. If the printer is ready to accept data, it signals the computer by setting the BUSY handshake line low. The computer then sends the data to the printer. When the data is sent, the computer sets the STROBE handshake line low.

To set up an intermediate buffer for the data, two routines are needed to coordinate the data flow. One routine writes the data that is normally sent to the printer to the buffer. Another routine sends the data from the buffer to the printer when the printer is ready to accept data.

This program is set to manage a buffer of up to 63K. By clicking the mouse, the program reserves a 32K buffer. This is enough for about 15 pages of text. By running the program as a TTP (TOS Takes Parameters) file, you can specify the buffer size—any value between 1 and 63 sets the size in kilobytes.

If you anticipate using the print spooler often, you can have have it installed each time you boot the operating system. Place a folder called AUTO on the operating system diskette and copy the program to this folder. When the system is booted, all the programs in the AUTO folder are executed alphabetically.

Here's a short description of the print spooler:

So that the print spooler reserves enough space for both itself and the buffer, the size of the memory area is determined. This is found in the *base page*, which is 256 bytes long. It immediately precedes the program. The address of the base page is found on the stack. The lengths of text, data, and block storage segments are added to the length of the base page.

The base page also contains the *command line.* The command line is the text that we entered as parameters of the program to start the program. The parameter represents the buffer size (in kilobytes). The parameter in the command line is converted to a binary number. If a parameter is omitted, a 32K buffer is the default. By shifting the number in a register, the value is converted to the exact buffer size.

Next we change the system for the `TRAP#13` instruction to point to our print spooler program. In this program we'll test the parameter on the stack, to determine if either the printer output or the printer status is being requested. If a service other than these two is requested, then the original `TRAP#13` routine is performed.

There are several situations that our print spooler must consider:

- If the buffer is empty, we try to output the character directly to the printer.
- If the printer is not ready to accept a character, or the buffer is not empty, then we write the character to the buffer.
- If the buffer is full, then we wait 30 seconds. If the buffer does not have space after 30 seconds we inform the requester that the character cannot be output. This occurs when the buffer is full and the printer is not accepting any more data.

How do we get data from the buffer to the printer?

The BUSY line of the printer generates an interrupt when it is ready to receive the next character. By vectoring this interrupt to our routine labeled `busyint`, we can transfer data from the buffer to the printer. In this interrupt routine, we check to see if there is data remaining in the buffer. If so, one character is removed and sent to the printer. This ends the interrupt routine; control is returned to the interrupted program. The advantage of this method is that the computer doesn't spend time waiting for the printer.

If you install this print spooler and send a 10-page document to the printer, the computer will be ready for further processing in a very short time—even though the printer continues to work for several minutes afterwards.

Following is the assembly language listing for the print spooler program. There is also a BASIC loader program to create an equivalent machine language program on diskette.

```
*
*       print spooler for atari st
*
*       LE/RB, 5/11/85
*

bios    equ     13
keep    equ     $31             hold resident prg
gemdos  equ     1
setexec equ     5               set xception vector
conout  equ     3               output character
constat equ     8               output status
prn     equ     0               device # of printer
savptr  equ     $4a2            save area/ register
hz_200  equ     $4ba            200 hz system count

xbios   equ     14
mfpint  equ     13              mfp interrupt
*                               installed

mfp     equ     $fffa01         mfp 68901
psg     equ     $ff8800         psg ym 2149
isrb    equ     $10             interrupt service
*                               register b

default equ     32              standard buffer
*                               size in kb
timeout equ     30              30 seconds timeout

*                               compute program size

        move.l  4(sp),a0        base page address
        move.l  #$100,d6        size of base page
        add.l   12(a0),d6       plus text length
        add.l   20(a0),d6       plus data length
        add.l   28(a0),d6       plus bss length

*                       buffer size from command line
        moveq   #0,d7
        moveq   #0,d0
        lea     129(a0),a0      command line pntr
nextchr move.b  (a0)+,d0        get character
        sub.b   #'0',d0
```

```
        bmi     exit            no number
        cmp.b   #9,d0
        bgt     exit            no number
        mulu    #10,d7          next place
        add     d0,d7
        bra     nextchr

exit    tst     d7              has no. been input?
        bne     ok              yes
        move    #default,d7     otherwise take
*                               default number
ok      ext.l   d7
        moveq   #10,d0
        lsl.l   d0,d7           convrt valu to bytes
        add.l   d7,d6           add to place needs
        move    d7,length       and enter in iorec

*                               initialize vectors

        move.l  #trap13,-(sp)   new vector
        move    #45,-(sp)       vector number
        move    #setexec,-(sp)
        trap    #bios           set vector
        addq.l  #8,sp
        move.l  d0,trapsve      note old vector

        move.l  #busyint,-(sp)
        move    #0,-(sp)        int number
        move    #mfpint,-(sp)
        trap    #xbios          centronics interrupt
*                               enabled
        addq.l  #8,sp

        clr     -(sp)
        move.l  d6,-(sp)        number of bytes
        move    #keep,-(sp)     hold resident program
        trap    #gemdos         back to desktop

*                               new trap#13 routine
trap13  move.l  sp,a2           mark ssp
        btst    #5,(sp)         call from supervisor?
        bne     super           yes
        move.l  usp,a2          otherwise use usp
```

```
        subq    #6,a2
super   cmp     #conout,6(a2)  conout-call ?
        bne     normal
        cmp     #prn,8(a2)    printer ?
        bne     normal

        move.l  savptr,a1     pointer to save area
        move    (sp)+,-(a1)   retain status
        move.l  (sp)+,-(a1)   return address
        move.l  a1,savptr     save ptr updates

        move    10(a2),d1     character
        bsr     print

        move.l  savptr,a1
        move.l  (a1)+,-(sp)   return address
        move    (a1)+,-(sp)   status
        move.l  a1,savptr
        rte

normal:
        cmp     #constat,6(a2) printer status ?
        bne     norm1
        cmp     #prn,8(a2)
        bne     norm1         over old trap#13
*                             vector

        moveq   #-1,d0        status ok taken
        bsr     getptr        get pointer
        move    tail(a0),d2
        bsr     wrap
        cmp     head(a0),d2   room in buffer?
        bne     room          yes
        moveq   #0,d0         busy, no room
room    rte

norm1   move.l  trapsve,a0    to old trap #13
        jmp     (a0)

print   move    #$2700,sr     interrupt block
        bsr     getptr        pntr to iorec & mfp
        move    head(a0),d2
        cmp     tail(a0),d2   buffer empty?
```

```
        bne     inbuff          no char in buffer

loop    btst    #0,(a1)         printer busy ?
        bne     inbuff          yes,in buffer

notbusy lea     psg,a2          psg address
        move.b  #15,(a2)        reg. number port b
        move.b  d1,2(a2)        output databyte

        move.b  #14,(a2)        reg number port a
        move.b  (a2),d0
        and.b   #$df,d0         strobe low
        move.b  d0,2(a2)

        or.b    #$20,d0         strobe high
        move.b  d0,2(a2)

        moveq   #-1,d0          ok
        rts


inbuff  move    tail(a0),d2     increment
        bsr     wrap            write pointer
        cmp     head(a0),d2     buffer full?
        beq     buffull         yes
inbuff1 move.l  (a0),a1         buffer address
        move.b  d1,(a1,d2)      write char to buffer
        move    d2,tail(a0)     mark new tail index
        moveq   #-1,d0          character disposed of
        rts

buffull move.l  hz_200,d0
        add.l   #timeout*200,d0 num seconds to wait
        move    #$2300,sr       interrupts freed up
wait    cmp     head(a0),d2     more room in buffer?
        bne     inbuff1         yes-char into buffer
        cmp.l   hz_200,d0       time up yet?
        bhi     wait            no-keep waiting

        moveq   #0,d0           char not disposed of
        rts
*       interrupt routine for sending a character
*       to the printer
```

```
busyint movem.l d0-d2/a0-a2,-(sp)  retain
*                                  register
        bsr     getptr          get pointer
        move    head(a0),d2
        cmp     tail(a0),d2     send buffer empty?
        beq     empty           yes- ready
        bsr     wrap            incremnt read pointer
        move.l  (a0),a2         buffer address
        move.b  (a2,d2),d1      send char from
        bsr     notbusy         buffer to printer
        move    d2,head(a0)     mark new head index
empty   bclr    #0,isrb(a1)     clr  service bit
        movem.l (sp)+,d0-d2/a0-a2 restore registers
        rte

getptr  lea     iorec,a0        pointer to
*                               buffer file record
        lea     mfp,a1
        rts

wrap    addq    #1,d2           pointer to next pos.
        cmp     len(a0),d2      reachd end-of-buffer?
        bcs     nowrap          no
        moveq   #0,d2           otherwise start
*                               at the beginning
nowrap  rts

        .data
iorec   dc.l    buf             buffer address
length  ds.w    1               buffer size
        dc.w    0               write index
        dc.w    0               read index

buffer  equ     0               offset in iorec
len     equ     4
head    equ     6
tail    equ     8

        .bss
trapsve ds.l    1               alter trap#13 vector
buf     equ     *       start of buffer memory
```

## BASIC loader for print spooler

```
100 open "R",1,"b:spool.prg",16: rem drive b
110 field#1,16 as bin$
120 a$="": for i=1 to 16: read x$: if x$="*"then 150
130 a=val("&H"+x$): s=s+a:a$=a$+chr$(a): next
140 lset bin$=a$: rec=rec+1: put 1,rec: goto 120
150 data 60,1A,00,00,01,B0,00,00,00,0A,00,00,00,04,00,00
160 data 00,00,00,00,00,00,00,00,00,00,00,00,20,6F,00,04
170 data 2C,3C,00,00,01,00,DC,A8,00,0C,DC,A8,00,14,DC,A8
180 data 00,1C,7E,00,70,00,41,E8,00,81,10,18,90,3C,00,30
190 data 6B,0E,B0,3C,00,09,6E,08,CE,FC,00,0A,DE,40,60,EA
200 data 4A,47,66,02,7E,20,48,C7,70,0A,E1,AF,DC,87,33,C7
210 data 00,00,01,B4,2F,3C,00,00,00,7C,3F,3C,00,2D,3F,3C
220 data 00,05,4E,4D,50,8F,23,C0,00,00,01,BA,2F,3C,00,00
230 data 01,6C,3F,3C,00,00,3F,3C,00,0D,4E,4E,50,8F,42,67
240 data 2F,06,3F,3C,00,31,4E,41,24,4F,08,17,00,05,66,04
250 data 4E,6A,5D,4A,0C,6A,00,03,00,06,66,30,0C,6A,00,00
260 data 00,08,66,28,22,79,00,00,04,A2,33,1F,23,1F,23,C9
270 data 00,00,04,A2,32,2A,00,0A,61,42,22,79,00,00,04,A2
280 data 2F,19,3F,19,23,C9,00,00,04,A2,4E,73,0C,6A,00,08
290 data 00,06,66,20,0C,6A,00,00,00,08,66,18,70,FF,61,00
300 data 00,C2,34,28,00,08,61,00,00,C8,B4,68,00,06,66,02
310 data 70,00,4E,73,20,79,00,00,01,BA,4E,D0,46,FC,27,00
320 data 61,00,00,A0,34,28,00,06,B4,68,00,08,66,2E,08,11
330 data 00,00,66,28,45,F9,00,FF,88,00,14,BC,00,0F,15,41
340 data 00,02,14,BC,00,0E,10,12,C0,3C,00,DF,15,40,00,02
350 data 80,3C,00,20,15,40,00,02,70,FF,4E,75,34,28,00,08
360 data 61,6E,B4,68,00,06,67,0E,22,50,13,81,20,00,31,42
370 data 00,08,70,FF,4E,75,20,39,00,00,04,BA,D0,BC,00,00
380 data 17,70,46,FC,23,00,B4,68,00,06,66,DC,B0,B9,00,00
390 data 04,BA,62,F2,70,00,4E,75,48,E7,E0,E0,61,24,34,28
400 data 00,06,B4,68,00,08,67,0E,61,26,24,50,12,32,20,00
410 data 61,82,31,42,00,06,08,A9,00,00,00,10,4C,DF,07,07
420 data 4E,73,41,F9,00,00,01,B0,43,F9,00,FF,FA,01,4E,75
430 data 52,42,B4,68,00,04,65,02,74,00,4E,75,00,00,01,BE
440 data 00,00,00,00,00,00,00,00,00,44,06,12,06,88,AE,18
450 data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
460 data *
470 close 1:if s<> 29742 then print "Error in DATA!!": end
480 print "Ok."
```

## 2.3 RAM-disk for the ST

If you've done any program development on the ST, then you're familar with the number of steps required to create an executable PRG file from the source. You need the editor, source file, compiler or assembler, linker, etc. In addition, several temporary files are created and deleted. These activities—editing, compiling and linking—are disk-intensive activities. Longer programs may take 15 minutes or more to compile. In our opinion, too much of the time is spent loading and saving data in disk files.

One way to speed up the process is to use a hard drive. This speeds up disk access by about 30 times. Another alternative, which is faster and much less expensive, is the *RAM disk.*

What is a RAM disk? Quite simply, a RAM disk is a disk drive facsimile that's located in memory. By setting aside an area of memory in the ST and treating it like a peripheral device—a disk drive—you can get a super fast and super cheap disk drive.

When data from the computer is sent to a RAM disk, it is not sent to the disk controller, but to the reserved memory. And it's done at the lightning speed of the 68000 processor—not at the plodding mechanical speed of a real disk drive.

Reading and writing to and from the RAM disk is equivalent to copying data from one area of memory to another.

To simulate the RAM disk, several routines are required. One routine is tied to the operating system. Three vectors are *patched.* These vectors are designed to be used by the hard disk, but can be used for our purposes here. They involve calls to the BIOS for reading/writing sectors, getting the BIOS parameter block (contains information about the physical organization of a disk) and determining if the diskette is changed.

The RAM disk here will have the designation C. This corresponds to a value of 2 in the BIOS (0=drive A, 1=drive B, etc.). In the program, the normal vectors are altered to point to our routines. We determine if the RAM disk (drive C) is the intended destination by checking the drive number on the stack. If drive C is not the destination, we return control to the normal vector for drives A and B.

When starting the RAM disk program, the size of the RAM disk is passed as a parameter. You specify the capacity of the RAM disk in kilobytes (same as for the print spooler). You are not limited to the preset disk sizes (180, 360, and 720K)—any size from 80K to 640K (on a 1040 ST) can be specified.

On a 520 ST, values from 100 to 220K are possible. If you don't specify a parameter, the default is 100K. Using the assembler, you can change the default RAM disk capacity by changing the appropriate source code.

Using the BASIC loader, you must change the underlined values with your new default value (high byte, low byte; example, for 300K: 01 2C). The RAM disk program automatically configures the BIOS parameter block for the specified parameter, creates a boot sector in RAM, and initializes the directory.

To install the RAM disk, execute the `RAMDISK.PRG` program, with or without parameters. The capacity of the RAM disk is specified by installing this application from the `OPTIONS` menu as a `TTP` (TOS Takes Parameters) file. When the `RAMDISK.PRG` application is started, simply enter the desired capacity in the dialog box and press <RETURN>. Next click the icon for drive A and choose the selection `INSTALL DISK DRIVE` from the `OPTIONS` menu. Enter `C` for the disk drive identifier, and `RAM_DISK` for the icon label. Then click the `INSTALL` box. A new disk icon appears on the screen with the label `RAM_DISK`.

You can now open the RAM disk by double-clicking this icon. A window with the identification `C` then appears, containing 0 objects with 0 bytes. You can copy programs or files from drive A or B to the RAM disk. This is done exactly as if we were using actual disk drives.

Try loading a program from the RAM disk. Programs up to 100K will load in less than one second!

How can we best use the RAM disk? If you write a lot of programs and documents you should put the editor and source program on the RAM disk. If you have enough room, put the compiler, assembler and linker on the RAM disk also. A complete assembler pass may take up to ten minutes with a regular disk drive. The same pass will take less than a minute with the RAM disk.

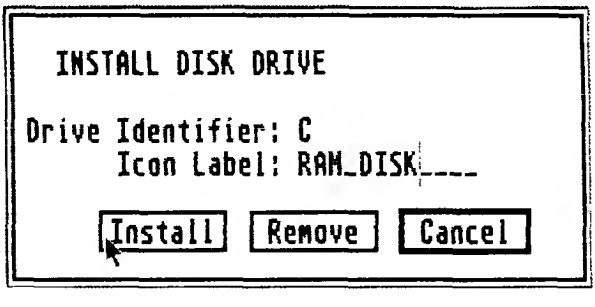
**Warning**: Remember that your data on the RAM disk is only in RAM—it will be lost forever when you turn the power off! Copy the results of your work from the RAM disk to a real disk drive before turning the computer off! You should also do the same before you start untested programs that might cause the system to crash.

Here are a few hints for working with the RAM disk:

- It's not possible to back up an entire floppy disk to the RAM disk, or vice versa. Instead, try the following method. Open a window of the drive *to* which you want to copy. Then drag the icon of the diskette *from* which you want to copy into the window.

- You should also not try to format the RAM disk. Doing so may damage the diskettes in drives A and B. Instead, draw a box around all the file icons on the RAM disk, and drag them to the trash. This is done very quickly with the RAM disk.

- You can also automatically install the RAM disk after power-up. To do this, place a folder titled `AUTO` on your system disk and copy the installation program `RAMDISK.PRG` to it. When you select `SAVE DESKTOP` from the `OPTIONS` menu, your configuration with the installed RAM disk is stored in the file `DESKTOP.INF`. Make sure this file is saved on drive A and not drive C. If it is saved on drive C copy it to drive A. From then on, every time the system is booted, the RAM disk is automatically installed as drive C.



```
*
*       RAM disk for ATARI ST
*       LE/RB, 6/11/85
*

hdv_bpb equ     $472            bios parameter block
hdv_rw  equ     $476            read/write sectors
hdv_mediach     equ     $47e

drvbits equ     $4c2            bit vectors of
*                               active drives

gemdos  equ     1
keep    equ     $31

xbios   equ     14
super   equ     38

default equ     100             standard capacity
*                               in kb

init    move.l  4(sp),a0        base page address
        move.l  #$100,d6        size of base page
        add.l   12(a0),d6       text length
        add.l   20(a0),d6       data length
        add.l   28(a0),d6       bss length

        moveq   #0,d7
        moveq   #0,d0
        lea     129(a0),a0      pointer to
*                               command line
nextchr move.b  (a0)+,d0        first character
*                               from command line
        sub.b   #'0',d0
        bmi     exit
        cmp.b   #9,d0           number?
        bgt     exit
        mulu    #10,d7
        add     d0,d7           next digit
        bra     nextchr

exit    tst     d7              input done there?
        bne     ok
```

```
        move.w  #default,d7     default value

ok      moveq   #0,d1
        move    d7,d1           capacity in k
        add     #9,d1           plus 9 k
        lsl.l   #8,d1
        lsl.l   #2,d1           * 1024
        add.l   d1,d6           add to memory
*                               requirements


        move.l  #init1,-(sp)
        move    #super,-(sp)    initialization in
*                               supervisor mode
        trap    #xbios
        addq.l  #6,sp

        clr     -(sp)
        move.l  d6,-(sp)        number of bytes
        move    #keep,-(sp)     leave resident prg
        trap    #gemdos         return to desktop


init1   move.l  hdv_bpb,bpbsave
        move.l  #bpb,hdv_bpb

        move.l  hdv_rw,rwsave   set vectors to
*                               new routines
        move.l  #rw,hdv_rw

        move.l  hdv_mediach,mediasave
        move.l  #media,hdv_mediach


install moveq   #0,d1
        lea     ramdisk,a0
        move    #2*9*512/4-1,d0
*                               clear tracks 0 and 1
iloop1  move.l  d1,(a0)+        of ram disk
        dbra    d0,iloop1

*                               generate boot sector
        lea     ramdisk+11,a0
```

```
        lea     boottab,a1
        moveq   #tabend-boottab-1,d0
bloop   move.b  (a1)+,(a0)+     copy data in
*                               boot sector
        dbra    d0,bloop

        move    d7,numcl        capacity in kb
*                               in bpb

        lsl     #1,d7           sector capacity
        add     #18,d7          plus 18 sectors
        lea     ramdisk+19,a0
        move.b  d7,(a0)+        low-byte
        lsr     #8,d7
        move.b  d7,(a0)         high-byte

        or.l    #%100,drvbits   inform drive c
        rts

bpb:    cmp     #2,4(sp)        drive c ?
        beq     bpb1            yes

        move.l  bpbsave,a0      old routine
        jmp     (a0)

bpb1    move.l  #bpbtab,d0      pointer to bios
*                               parameter block
        rts

rw      cmp     #2,14(sp)       drive c ?
        beq     rw1             yes

        move.l  rwsave,a0       old routine
        jmp     (a0)

rw1     move    12(sp),d0       recno, logical
*                               sector number
        ext.l   d0
        lsl.l   #8,d0
        lsl.l   #1,d0           times 512

        move.l  6(sp),a0        buffer address
```

```
        move    10(sp),d1       number of sectors
        subq    #1,d1
        lea     ramdisk,a1      basis address
        add.l   d0,a1           plus relative
*                               address in ram disk

        move    4(sp),d0        rwflag
        btst    #0,d0           read?
        beq     rloop0          yes
        exg     a0,a1           exchange destination
*                               and source

rloop0  move    #511,d0         copy a sector
rloop   move.b  (a1)+,(a0)+     to buffer
        dbra    d0,rloop
        dbra    d1,rloop0       next sector
        moveq   #0,d0           ok
        rts


media   cmp     #2,4(sp)        drive c ?
        beq     media1          yes

        move.l  mediasave,a0    old routine
        jmp     (a0)

media1  moveq   #0,d0           diskete not changed
        rts

        .data
bpbtab:
recsiz: dc.w    $200            sector size
clsiz   dc.w    2               cluster size
*                               in sectors
clsizb  dc.w    $400            cluster size
*                               in bytes
rdlen   dc.w    7               directory length
*                               in sectors
fsiz    dc.w    5               fat size
fatrec  dc.w    6               fat sectors
datrec  dc.w    18              sectors for
*                               data management
numcl   ds.w    1               capacity in kb
```

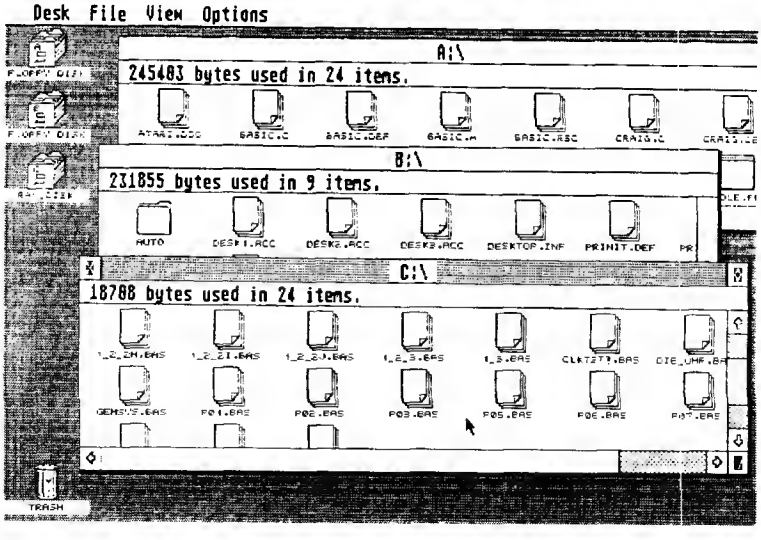
```
flags   ds.w    8

boottab:        *               data in 8086 format
        dc.b    0,2             bytes per sector
        dc.b    2               sectors per cluster
        dc.b    1,0             reserved sectors
        dc.b    2               fats
        dc.b    112,0           directory entries
        ds.b    2               sectors on media
        dc.b    0               media descriptor
        dc.b    5,0             sectors per fat
        dc.b    9,0             sectors per track
        dc.b    1,0             sides
        dc.b    0               hidden
tabend  equ     *

        .bss

bpbsave ds.l    1               room for old
*                               floppy vectors
rwsave  ds.l    1
mediasave       ds.l    1

ramdisk equ     *               ram disk starts here
```



## BASIC loader for RAM disk

```
100 open "R",1,"b:ramdisk.prg",16: rem drive b
110 field#1,16 as bin$
120 a$="": for i=1 to 16: read x$: if x$="*"then 150
130 a=val("&H"+x$): s=s+a:a$=a$+chr$(a): next
140 lset bin$=a$: rec=rec+1: put 1,rec: goto 120
150 data 60,1A,00,00,01,5E,00,00,00,32,00,00,00,0C,00,00
160 data 00,00,00,00,00,00,00,00,00,00,00,00,20,6F,00,04
170 data 2C,3C,00,00,01,00,DC,A8,00,0C,DC,A8,00,14,DC,A8
180 data 00,1C,7E,00,70,00,41,E8,00,81,10,18,90,3C,00,30
190 data 6B,0E,B0,3C,00,09,6E,08,CE,FC,00,0A,DE,40,60,EA
200 data 4A,47,66,04,3E,3C,00,64,72,00,32,07,D2,7C,00,09
210 data E1,89,E5,89,DC,81,2F,3C,00,00,00,62,3F,3C,00,26
220 data 4E,4E,5C,8F,42,67,2F,06,3F,3C,00,31,4E,41,23,F9
230 data 00,00,04,72,00,00,01,90,23,FC,00,00,00,E8,00,00
240 data 04,72,23,F9,00,00,04,76,00,00,01,94,23,FC,00,00
250 data 01,00,00,00,04,76,23,F9,00,00,04,7E,00,00,01,98
260 data 23,FC,00,00,01,4A,00,00,04,7E,72,00,41,F9,00,00
270 data 01,9C,30,3C,08,FF,20,C1,51,C8,FF,FC,41,F9,00,00
280 data 01,A7,43,F9,00,00,01,7E,70,11,10,D9,51,C8,FF,FC
290 data 33,C7,00,00,01,6C,E3,4F,DE,7C,00,12,41,F9,00,00
300 data 01,AF,10,C7,E1,4F,10,87,00,B9,00,00,00,04,00,00
310 data 04,C2,4E,75,0C,6F,00,02,00,04,67,08,20,79,00,00
320 data 01,90,4E,D0,20,3C,00,00,01,5E,4E,75,0C,6F,00,02
330 data 00,0E,67,08,20,79,00,00,01,94,4E,D0,30,2F,00,0C
340 data 48,C0,E1,88,E3,88,20,6F,00,06,32,2F,00,0A,53,41
350 data 43,F9,00,00,01,9C,D3,C0,30,2F,00,04,08,00,00,00
360 data 67,02,C1,49,30,3C,01,FF,10,D9,51,C8,FF,FC,51,C9
370 data FF,F4,70,00,4E,75,0C,6F,00,02,00,04,67,08,20,79
380 data 00,00,01,98,4E,D0,70,00,4E,75,02,00,00,02,04,00
390 data 00,07,00,05,00,06,00,12,00,00,00,00,00,00,00,00
400 data 00,00,00,00,00,00,00,00,00,00,00,02,02,01,00,02
410 data 70,00,00,00,00,05,00,09,00,01,00,00,00,00,00,4C
420 data 1C,06,0E,06,0E,06,0C,10,06,CE,0C,20,08,10,1C,2E
430 data *
440 close 1:if s<> 26687 then ? "Error in DATA!!": end
450 print "Ok."
```

## 2.4 Auto-starting TOS applications

On early versions of ST, the operating system is loaded from disk to memory and started. To initiate this procedure, the ST has a boot ROM which automatically executes when the computer is turned on. The boot ROM loads a special boot sector from the system diskette, which in turn loads the rest of the operating system.

The boot sector occupies the first sector on the system disk (track zero, sector one) and contains data about the disk format, capacity, number of tracks and sectors, and size and organization of the directory. The boot program is contained only on a systems disk. So that the ST can recognize a system disk, the checksum of this sector is $1234.

Normally, after the operating system is loaded, the GEM desktop is started. But the operating system can start a program called `COMMAND.PRG` instead. This may be a user program which runs under TOS, for example. How do we get the operating system to do this?

Within the boot sector is a flag which determines whether the desktop or `COMMAND.PRG` is started. If the flag is zero, the desktop is started. If the value at the address is not zero, `COMMAND.PRG` is started. The value of the flag is copied to the system variable `cmdload` which is found at $482. After the operating system is loaded, it uses `cmdload` to decide which program to start.

To be able to start an application on boot-up, we must modify the boot sector. Following is a small utility program to do this.

The program performs several functions:

First the boot sector from drive A is read and the flag for `cmdload` is set in the boot sector.

Now we can rewrite the boot sector to drive B. But, recall that there is a checksum to identify the boot sector. Changing a value within the sector changes the checksum. The operating system will no longer recognize the disk as a systems disk. Instead of determining the new checksum, we can let the operating system do it for us. Function `protobt` creates a boot sector or changes one already existing.

We specify that the boot sector is to be executable and all other parameters are to remain unchanged. This routine recalculates the checksum and rewrites the boot sector.

Finally we can copy the application to be automatically started after booting to the modified disk. The program must have the name COMMAND.PRG.

If we reboot with this disk in drive A, this program is automatically started!

This program requires a disk with a boot sector to be in drive A, such as the system disk. This program will read the boot sector and then write the modified boot sector to drive B.

```
*
*       modification of boot sectors for cmdload
*       LE 11/11/85
*

gemdos  equ     1

xbios   equ     14

floprd  equ     8               read sector
flopwr  equ     9               write sector
protobt equ     18              genrate boot sector

cmdload equ     $1e             offset in boot sector

*               load boot sector

        move    #1,-(sp)        one sector
        move    #0,-(sp)        side zero
        move    #0,-(sp)        track zero
        move    #1,-(sp)        sector zero
        move    #0,-(sp)        drive a
        clr.l   -(sp)
        move.l  #buffer,-(sp)   buffer address
        move    #floprd,-(sp)   boot read sector
        trap    #xbios
        add.l   #20,sp

        tst     d0              error occurred?
        bne     exit            yes- break

*               boot sector modified

        lea     buffer,a0       buffer address
        move.b  #1,cmdload(a0)  set cmdload flag

*               make boot sector operational again

        move    #1,-(sp)        make boot sector
*                               operational
        move    #-1,-(sp)       disk type stays same
        move.l  #-1,-(sp)       serial number
*                               stays the same
```

```
        move.l  #buffer,-(sp) boot sector address
        move    #protobt,-(sp)call function
        trap    #xbios
        add.l   #14,sp

*               write altered boot sector back in

        move    #1,-(sp)      one sector
        move    #0,-(sp)      side zero
        move    #0,-(sp)      track zero
        move    #1,-(sp)      sector zero
        move    #1,-(sp)      drive b
        clr.l   -(sp)
        move.l  #buffer,-(sp) buffer address
        move    #flopwr,-(sp) boot zero
        trap    #xbios
        add.l   #20,sp

exit    clr     -(sp)
        trap    #gemdos       return to desktop

        .bss
buffer  ds.b    512           room for a sector
```

```
100 open "R",1,"b:cmdload.prg",16 : rem drive b
110 field#1,16 as bin$
120 a$="": for i=1 to 16: read x$: if x$="*"then 150
130 a=val("&H"+x$): s=s+a:a$=a$+chr$(a): next
140 lset bin$=a$: rec=rec+1: put 1,rec: goto 120
150 data 60,1A,00,00,00,84,00,00,00,00,00,02,00,00,00
160 data 00,00,00,00,00,00,00,00,00,00,00,3F,3C,00,01
170 data 3F,3C,00,00,3F,3C,00,00,3F,3C,00,01,3F,3C,00,00
180 data 42,A7,2F,3C,00,00,00,84,3F,3C,00,08,4E,4E,DF,FC
190 data 00,00,00,14,4A,40,66,54,41,F9,00,00,00,84,11,7C
200 data 00,01,00,1E,3F,3C,00,01,3F,3C,FF,FF,2F,3C,FF,FF
210 data FF,FF,2F,3C,00,00,00,84,3F,3C,00,12,4E,4E,DF,FC
220 data 00,00,00,0E,3F,3C,00,01,3F,3C,00,00,3F,3C,00,00
230 data 3F,3C,00,01,3F,3C,00,01,42,A7,2F,3C,00,00,00,84
240 data 3F,3C,00,09,4E,4E,DF,FC,00,00,00,14,42,67,4E,41
250 data 00,00,00,18,16,1A,28,00,00,00,00,00,00,00,00,00
260 data *
270 close 1:if s<> 8275 then print "Error in DATA !!": end
280 print "Ok."
```

## 2.5 Using machine language and C

In this section we'll demonstrate how to use machine language subroutines from C programs.

Writing a program in C is usually much easier and faster than writing it in machine language. But when it comes to optimizing time-critical parts of a program, you must often rewrite these sections in machine language. Since the C compiler creates an assembly language program as an intermediate step, you might be tempted to optimize these parts by hand—changing the assembly language program.

How can you pass parameters between the C program and assembly language subroutine and get a result back? Parameters are usually passed on the stack:

```
int parameter1, parameter2;
long parameter3;
function(parameter1,parameter2,parameter3);
```

The C compiler generates the following assembler language statements from the above call:

```
move.l   parameter3,-(sp)
move.w   parameter2,-(sp)
move.w   parameter1,-(sp)
jsr      _function
addq.l   #8,sp
```

Note that the parameter list is processed from the back to the front, and also that the function is called with the JSR instruction. The C compiler places an underline character in front of the subroutine name. So that the linker can find the name in the assembly language program, it is declared as global.

For the assembly language program, the parameters are found on the stack as follows:

```
8(sp)     long, parameter3
6(sp)     word, parameter2
4(sp)     word, parameter1
0(sp)     long, return address from jsr call
```

You must ensure that the types of the parameters in the call match those in the subroutine; the compiler and linker cannot check types.

You must also pay attention to the register usage. An assembly language subroutine may change the contents of registers D0-D2 and A0-A2. No other register contents may be changed. If a function returns a result, it is expected in register D0. In this case, the compiler assumes that the function value is of type `int` or `word`, as with the following call:

```
a=function(parameter);
```

If the function returns a `long` result, it must be explicitly declared before the function is called, like this:

```
long function();
long a;

a=function(parameter);
```

Armed with this knowledge, you should be able to use assembly language subroutines. Following is an example of such a subroutine; it displays the directory. You'll see several GEMDOS calls. Toward the end of the listing is the short program `main`.

The function expects two parameters: The first determines the drive (0=A, 1=B); the second is a selection string that you can specify to select subdirectories, for example. If the second parameter is a null string, then all files are displayed. Twenty files are displayed per screen. Pressing a key displays the next twenty files.

```
*
*       Display directory
*
*       LE 11/11/85
*

*       BIOS-functions
bios    equ     13      TRAP#
conin   equ     2       console input
conout  equ     3       console output
con     equ     2       console device#

*       GEMDOS-functions
gemdos  equ     1       TRAP#
wrtstr  equ     9       string output
setdrv  equ     $e      drive selection
setdma  equ     $1a     declare dma-address
getspc  equ     $36     free bytes
sfirst  equ     $4e     search first
snext   equ     $4f     search next

cr      equ     13      carriage return
lf      equ     10      line feed

filetyp equ     %11001  file attribute

wrtchar move    d0,-(sp)        output char in d0
        move    #con,-(sp)
        move    #conout,-(sp)
        trap    #bios
        addq.l  #6,sp
        rts

blank   move.b  #' ',d0          output blanks

        bra     wrtchar

newline lea     crlf(pc),a0     new line

wrttxt  move.l  a0,-(sp)        text address
        move    #wrtstr,-(sp)   string output
        trap    #gemdos
        addq.l  #6,sp
```

```
        rts

         .globl  _directory      open access for C

*       6(sp)   filename pointer
*       4(sp)   drive number
*       0(sp)   return address

_directory:

        move    4(sp),curdrv    drive number
        move.l  6(sp),a0        filenames
        movem.l d3-d7/a3-a6,-(sp)       retain
*                                       C-register
        move.l  a0,a3
        move.l  #dmabuf,-(sp)
        move    #setdma,-(sp)   dma buffer address
        trap    #gemdos
        addq.l  #6,sp
        move    curdrv,-(sp)
        move    #setdrv,-(sp)   select drive
        trap    #gemdos
        addq.l  #4,sp
        tst.b   (a3)            filename onhand?
        bne     dir1            yes
        lea     allfile(pc),a3  '*.*' as name
dir1    move    #filetyp,-(sp)
        move.l  a3,-(sp)        filename pointer
        move    #sfirst,-(sp)
        trap    #gemdos
        addq.l  #8,sp
        tst     d0              file onhand?
        bne     enddir
dircont moveq   #20-1,d7        number of lines
nxtfile bsr     wrtname         output filename
        move.l  size,d0         size in bytes
        bsr     wrtlng          output as dec num.
        bsr     blank
        move    date,d3         date
        bsr     wrtdate         output
        bsr     blank           blank line
        move    time,d3         time
        bsr     wrttime         output
```

```
        bsr     newline         new line
        move    #snext,-(sp)
        trap    #gemdos         look for next file
        addq.l  #2,sp
        tst     d0              onhand?
        dbne    d7,nxtfile
        bne     enddir          no
        move    #con,-(sp)      wait for keypress
        move    #conin,-(sp)
        trap    #bios
        addq.l  #4,sp
        bra     dircont         and continue

enddir  move    curdrv,-(sp)    drive
        addq    #1,(sp)         1=a, 2=b
        move.l  #buffer,-(sp)
        move    #getspc,-(sp)   free space on disk
        trap    #gemdos
        addq.l  #8,sp
        move    buffer+2,d0     size
        bsr     wrt3dec         show as 3-digit
*                               dec. number
        lea     kfree(pc),a0
        bsr     wrttxt
        movem.l (sp)+,d3-d7/a3-a6       C-register
*                                       return
return  rts

wrtname lea     filenam,a6      filename formatted
*                               output
        clr     d6
namloop move.b  (a6)+,d0        get character
        beq     endnam1         name to end?
        cmp.b   #'.',d0
        beq     extens          continue via
*                               extension
        addq    #1,d6
        bsr     wrtchar         output character
        bra     namloop
extens  cmp     #9,d6           fill name to 8
*                               places
        beq     contue
        addq    #1,d6
```

```
        bsr     blank           fill with blanks
        bra     extens
contue  move.b  (a6)+,d0        extension output
        beq     endnam1
        addq    #1,d6
        bsr     wrtchar
        bra     contue
endnam1 cmp     #14,d6          end of name?
        beq     return
        bsr     blank           fill with blanks
        addq    #1,d6
        bra     endnam1

wrtdate bsr     blank           date display
        move    d3,d0
        and     #%11111,d0      isolate day
        bsr     wrt2dec         and display
        bsr     wrtpkt          '.' as separator
        move    d3,d0
        lsr     #5,d0
        and     #%1111,d0       isolate month and
        bsr     wrt2dec         display
         bsr     wrtpkt           '.' as separator

        move    d3,d0
        lsr     #8,d0
        lsr     #1,d0           isolate year
        add     #80,d0          add offset
        bra     wrt2dec         and output

wrtpkt  move.b  #'.',d0         output period
        bra     wrtchar

wrttime bsr     blank           output time
        move    d3,d0
        lsr     #8,d0
        lsr     #3,d0           isolate hour
        bsr     wrt2dec         and output
         bsr     wrtcol           ':' as separator

        move    d3,d0
        lsr     #5,d0
        and     #%111111,d0     isolate minutes
```

```
        bsr     wrt2dec         and output
        bsr     wrtcol          ':' as separator
        move    d3,d0
        and     #%11111,d0
        lsl     #1,d0           isolate seconds
        bra     wrt2dec         and output

wrtcol  move.b  #':',d0         output colon
        bra     wrtchar

wrt3dec moveq.l #3,d6           display d0 as
*                               3-digit no.
        clr     d4              suppress leading
*                               zeroes
        ext.l   d0
        bra     wrtlng1

wrt2dec moveq   #2,d6
        ext.l   d0              d0 as 2-digit
*                               decimal number
        st      d4              leading zeroes not
*                               suppressed
        bra   wrtlng1

*           hex number in d0.1 to decimal

wrtlng  clr     d4              suppress leading
*                               zeroes flag
        moveq   #10,d6

wrtlng1 movem.l d1-d3/d6-d7,-(sp)
        move.l  d0,d7
wrtdec5 moveq   #1,d2
        move.l  d6,d1
        subq.l  #1,d1
        beq     wrtdec1
wrtdec0 move    d2,d3           10*d3.1 to d3
        mulu    #10,d3
        swap    d2
        mulu    #10,d2
        swap    d3
        add     d3,d2
        swap    d2
```

```
        swap    d3
        move    d3,d2
        subq.l  #1,d1
        bne     wrtdec0
wrtdec1 clr.l   d0
wrtdec3 cmp.l   d2,d7
        blt     wrtdec2
        addq.l  #1,d0
        sub.l   d2,d7
        bra     wrtdec3
wrtdec2 tst.b   d0              zero?
        bne     wrtdec4         no-- output
        tst     d4
        bne     wrtdec4         suppress leading
*                               zeroes
        cmp     #1,d6           last place?
        beq     wrtdec4         yes-- display zero

        bsr     blank           leading zeroes
*                               displayed as blanks
        bra     wrtdec6
wrtdec4 add.b   #'0',d0
        bsr     wrtchar         display number
        st      d4              set flag
wrtdec6 subq.l  #1,d6
        bne     wrtdec5
        movem.l (sp)+,d1-d3/d6-d7
        rts

allfile dc.b    "*.*",0         all files
kfree   dc.b    " K free."
crlf    dc.b    cr,lf,0

       .bss
dmabuf  ds.b    22      dma buffer for gemdos
time    ds.w    1       time
date    ds.w    1       date
size    ds.l    1       file size
filenam ds.b    14      file name
curdrv  ds.w    1       current drive number
buffer  ds.b    16      file size buffer
```

The following short program in C can serve as a test for the directory subroutine.

```
/*
 *      test program for directory display
 *      LE 11/11/85
 */

main()

{
        directory (0,"");
                    /* drive a, all files       */

        directory (1,"*.PRG");
                    /* drive b, prg-files only  */

}
```

If you call the C source program `direc.c` and the assembly language program `dir.s`, then you would use the following command line after compilation and assembly for linking:

```
dir.68k=apstart,direc,dir
```

## BASIC loader for directory display

```
1000  open"R",1,"b:dir.prg",16
1010  field#1,16 as bin$
1020  a$="":for i=1 TO 16:read d$:if d$="*"then 1050
1030  a=val("&H"+d$):s=s+a:a$=a$+chr$(a):next
1040  lset bin$=a$:rec=rec+1:put 1,rec:goto 1020
1050  data 60,1A,00,00,02,72,00,00,01,64,00,00,04,42,00,00
1060  data 00,00,00,00,00,00,00,00,00,00,00,00,2A,4F,2E,7C
1070  data 00,00,07,D6,2A,6D,00,04,20,2D,00,0C,D0,AD,00,14
1080  data D0,AD,00,1C,D0,BC,00,00,01,00,2F,00,2F,0D,3F,00
1090  data 3F,3C,00,4A,4E,41,DF,FC,00,00,00,0C,4E,B9,00,00
1100  data 00,4A,2F,3C,00,00,00,00,4E,41,22,2F,00,04,30,3C
1110  data 00,C8,4E,42,4E,75,4E,56,FF,FC,2E,BC,00,00,03,CE
1120  data 42,67,4E,B9,00,00,00,9A,54,8F,2E,BC,00,00,03,CF
1130  data 3F,3C,00,01,4E,B9,00,00,00,9A,54,8F,4E,5E,4E,75
1140  data 3F,00,3F,3C,00,02,3F,3C,00,03,4E,4D,5C,8F,4E,75
1150  data 10,3C,00,20,60,EA,41,FA,01,E2,2F,08,3F,3C,00,09
1160  data 4E,41,5C,8F,4E,75,33,EF,00,04,00,00,08,06,20,6F
1170  data 00,06,48,E7,1F,1E,26,48,2F,3C,00,00,07,DA,3F,3C
1180  data 00,1A,4E,41,5C,8F,3F,39,00,00,08,06,3F,3C,00,0E
1190  data 4E,41,58,8F,4A,13,66,04,47,FA,01,94,3F,3C,00,19
1200  data 2F,0B,3F,3C,00,4E,4E,41,50,8F,4A,40,66,46,7E,13
1210  data 61,70,20,39,00,00,07,F4,61,00,01,14,61,92,36,39
1220  data 00,00,07,F2,61,00,00,9E,61,86,36,39,00,00,07,F0
1230  data 61,00,00,C0,61,80,3F,3C,00,4F,4E,41,54,8F,4A,40
1240  data 56,CF,FF,CE,66,0E,3F,3C,00,02,3F,3C,00,02,4E,4D
1250  data 58,8F,60,BA,3F,39,00,00,08,06,52,57,2F,3C,00,00
1260  data 08,08,3F,3C,00,36,4E,41,50,8F,30,39,00,00,08,0A
1270  data 61,00,00,AC,41,FA,01,1C,61,00,FF,40,4C,DF,78,F8
1280  data 4E,75,4D,F9,00,00,07,F8,42,46,10,1E,67,28,B0,3C
1290  data 00,2E,67,08,52,46,61,00,FF,08,60,EE,BC,7C,00,09
1300  data 67,08,52,46,61,00,FF,0A,60,F2,10,1E,67,08,52,46
1310  data 61,00,FE,EE,60,F4,BC,7C,00,0E,67,C4,61,00,FE,F2
1320  data 52,46,60,F2,61,00,FE,EA,30,03,C0,7C,00,1F,61,56
1330  data 61,18,30,03,EA,48,C0,7C,00,0F,61,4A,61,0C,30,03
1340  data E0,48,E2,48,D0,7C,00,50,60,3C,10,3C,00,2E,60,00
1350  data FE,B0,61,00,FE,BC,30,03,E0,48,E6,48,61,28,61,16
1360  data 30,03,EA,48,C0,7C,00,3F,61,1C,61,0A,30,03,C0,7C
1370  data 00,1F,E3,48,60,10,10,3C,00,3A,60,00,FE,84,7C,03
1380  data 42,44,48,C0,60,0C,7C,02,48,C0,50,C4,60,04,42,44
1390  data 7C,0A,48,E7,73,00,2E,00,74,01,22,06,53,81,67,1A
1400  data 36,02,C6,FC,00,0A,48,42,C4,FC,00,0A,48,43,D4,43
```

```
1410  data 48,42,48,43,34,03,53,81,66,E6,42,80,BE,82,6D,06
1420  data 52,80,9E,82,60,F6,4A,00,66,10,4A,44,66,0C,BC,7C
1430  data 00,01,67,06,61,00,FE,3A,60,0A,D0,3C,00,30,61,00
1440  data FE,20,50,C4,53,86,66,B0,4C,DF,00,CE,4E,75,2A,2E
1450  data 2A,00,20,4B,20,66,72,65,65,2E,0D,0A,00,00,00,01
1460  data 00,02,01,01,02,01,01,00,01,01,02,01,01,01,01,01
1470  data 00,00,00,00,00,00,00,00,00,00,01,00,00,01,00,03
1480  data 05,00,05,05,00,00,01,01,02,01,00,10,07,01,02,01
1490  data 00,00,00,00,00,00,00,00,00,00,01,01,01,02,01,01
1500  data 02,01,01,02,01,01,01,01,02,01,01,01,00,00,00,00
1510  data 00,00,00,00,00,00,00,00,02,01,01,01,01,01,06,01
1520  data 01,04,01,01,01,03,01,02,01,01,04,02,01,08,01,01
1530  data 00,00,00,00,00,00,01,01,01,09,01,01,01,01,01,01
1540  data 01,00,00,05,01,00,00,00,00,00,00,00,00,00,00,00
1550  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
1560  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
1570  data 00,00,04,03,00,08,03,00,06,01,00,08,01,00,08,01
1580  data 00,04,01,01,03,01,01,00,05,00,01,01,01,00,05,00
1590  data 00,01,01,00,01,01,00,00,00,00,00,00,00,00,00,00
1600  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,02
1610  data 02,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
1620  data 00,00,00,00,00,00,00,00,00,00,00,00,05,01,00,05
1630  data 01,00,01,01,00,01,01,00,02,05,00,06,01,00,02,01
1640  data 00,01,01,00,06,05,00,00,00,00,00,01,01,00,01,00
1650  data 02,01,00,02,01,01,01,01,01,00,00,00,00,00,00,00
1660  data 00,00,00,00,00,00,00,00,00,01,02,03,01,02,01,01
1670  data 01,01,01,01,00,01,01,00,01,02,00,2A,2E,50,52,47
1680  data 00,00,00,00,00,04,2E,1E,08,08,0A,34,10,0E,2C,0C
1690  data 0C,2A,08,0E,18,00,00,00,00,00,00,00,00,00,00,00
1700  data *
1710  close 1:if s<> 49400 then print"ERROR IN DATA!":end
1730  print "Ok."
```

**Sample screen dump of directory display program**

```
                          0  12.00.98   12:36:52
.                         0  12.00.98   12:36:52
CMDLOAD  PRG            168  04.01.86   19:19:10
DIR      O             1804  29.05.85   18:22:34
DIR      S             7563  04.01.86   19:19:20
DIR      PRG           1030  04.01.86   19:19:28
CMDLOAD  BAS            958  04.01.86   19:19:32
DIREC    O              212  29.05.85   17:34:06
DISKTIME BAK           4594  04.01.86   19:19:42
SPOOL    BAS           2136  04.01.86   19:19:48
RAMDISK  BAS           1962  04.01.86   19:19:54
RAMDISK  PRG            449  04.01.86   19:20:02
SPOOL    PRG            481  04.01.86   19:20:06
CMDLOAD  S             1918  04.01.86   19:20:10
DIREC    C              221  29.05.85   17:34:02
DISKTIME S             4608  29.05.85   18:10:34
RAMDISK  S             5363  04.01.86   19:20:28
SPOOL    S             7890  04.01.86   19:20:34
DISKTIME BAS           1998  29.05.85   18:26:18
DISKTIME PRG            448  29.05.85   18:26:54
```

# Chapter 3

# Hardcopy in color

## 3.1 ST hardcopy

One of the ST's most fascinating features is its great graphic capabilities. We don't have to tell you how crisp the hi-res mode is with the monochrome monitor. You can enjoy its graphics the minute you turn it on.

But there is one problem: how do we put these terrific images on paper? To be sure, there is as hardcopy routine in GEM. But this works only on a "normal" dot matrix printer. The various colors are shown as levels of grey. There is even a routine for a special color printer, but we never found out which one. Consequently, we wrote our own routine—and it's written so that it can be easily adapted to other printer models.

We also tried to get hardcopy on standard (color) plotters with a demo version of the drawing program GEMDRAW. We ran into problems with this, because we didn't know of a suitable hardcopy algorithm. But we solved this problem as well, as you'll see shortly.

We have also included a section on the layout of the graphics RAM. This layout will certainly prove useful when you implement your own graphics ideas.

The programs are all documented, so it won't be hard to modify them to suit your own needs. In addtion, we have listed both programs in BASIC, so even if you don't have an assembler you can still use the programs. Included in this chapter are many high-quality screen photos and hardcopies.

**Note:** For publishing reasons the color pages must be bound together. All the color illustrations are labeled as Plates. All Plates are located in the color section at the end of this book.

## 3.2 The screen display

The ST's screen display is memory mapped from video RAM. This is both a strength and weakness. 32K of video RAM is set aside for the screen display.

For graphics, the setup of video RAM is ideal. Points can be easily set and reset, thereby making graphics display extremely fast.

For text, the setup is less than ideal. To display a character, the character's image is copied pixel by pixel from the RAM-based font set directly to video RAM. This method is much slower than other hardware character generators, and the slow speed is especially noticeable during scrolling, when a large amount of memory must be moved. This would be unbearable if the 68000 wasn't so fast.

Obviously the ST is designed to optimize graphics at the expense of text. Let's talk more about the ST's graphics.

In high-resolution mode (640x400), the ST allows two colors: black and white. Figure 3.2-1 illustrates the relationship of video RAM to the screen display. Since there are only two colors in hi-res mode, one bit suffices to determine the color. Thus one bit in video RAM corresponds to one point on the screen. The high-order bit of the first word of video RAM corresponds to the upper left-hand point of the screen. Figure 3.2-2 is a hardcopy of this screen display mode.

In medium-resolution mode (640x200), the ST allows four colors. How is the color represented in video RAM? In this mode, two bits of video RAM correspond to one point on the display. The two bits represent the color of that point. Two bits can contain up to four different values: 0, 1, 2 and 3. As you can see from figure 3.2-3, the two bits are adjacent words in video RAM. So that the display appears full with a reduced number of vertical points, a point in medium resolution mode is stretched, so that a point is really a short vertical line.

Figure 3.2-1

## High Resolution Mode (2)

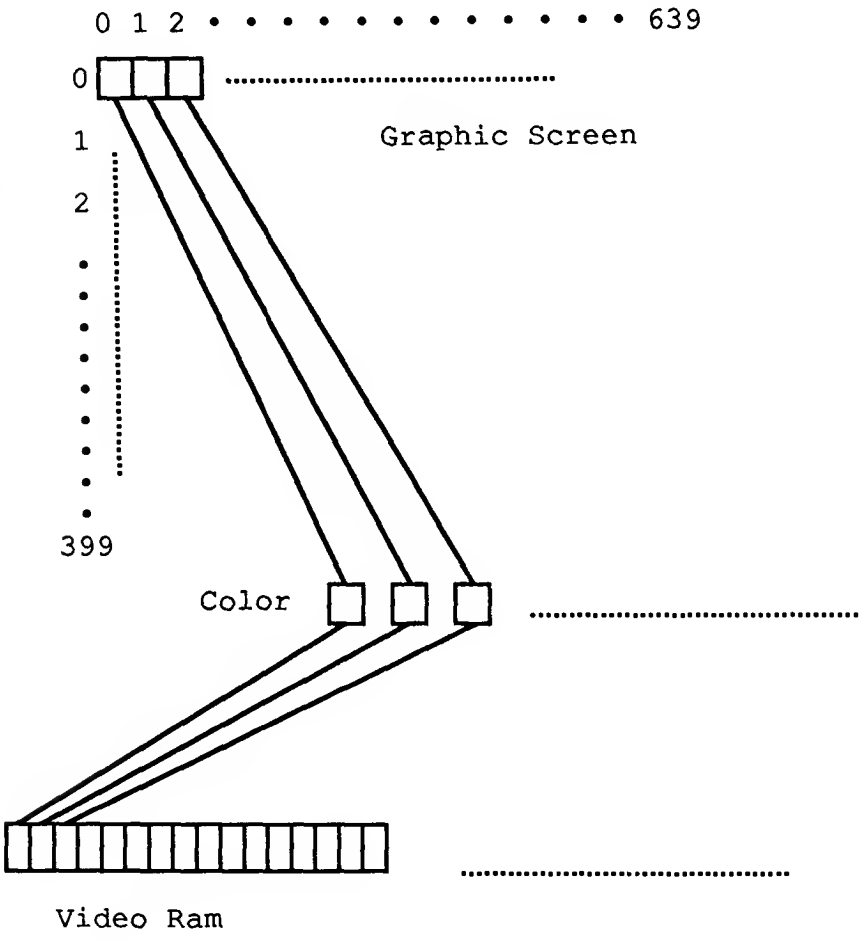


Figure 3.2-2

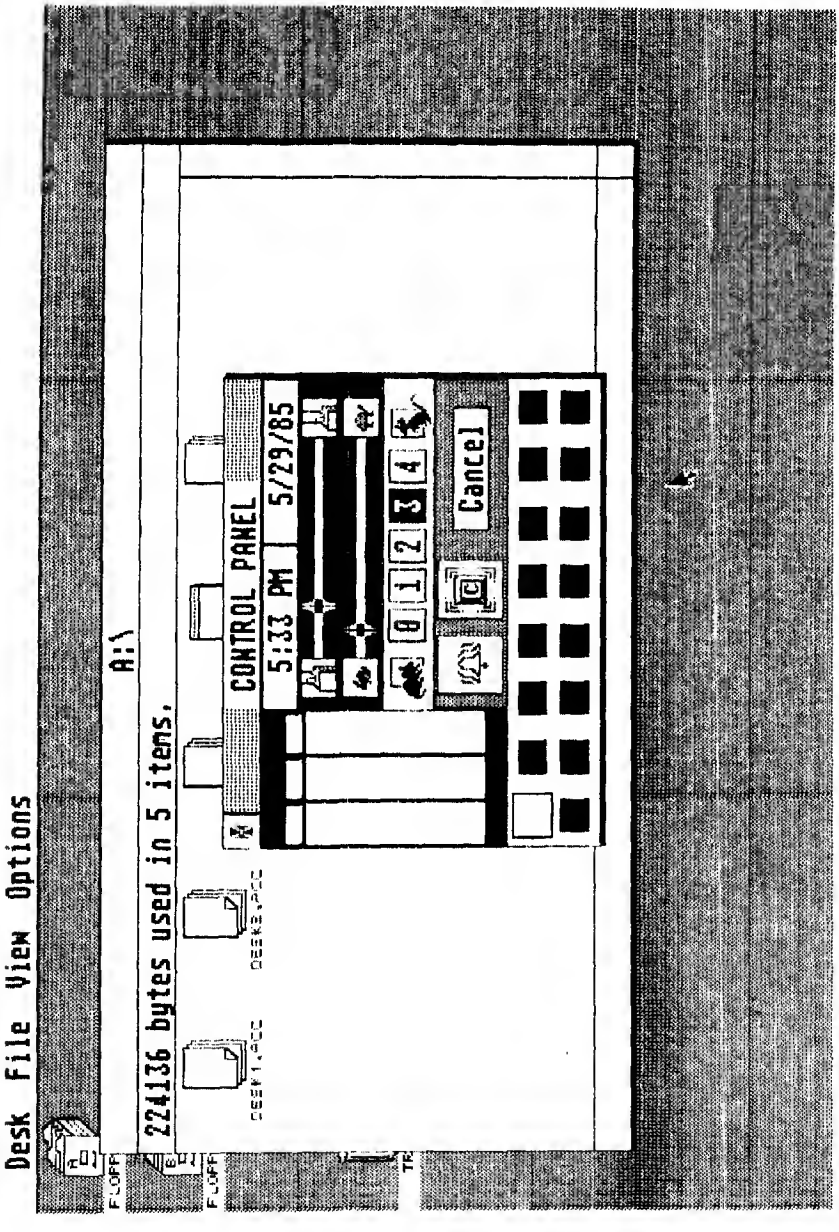
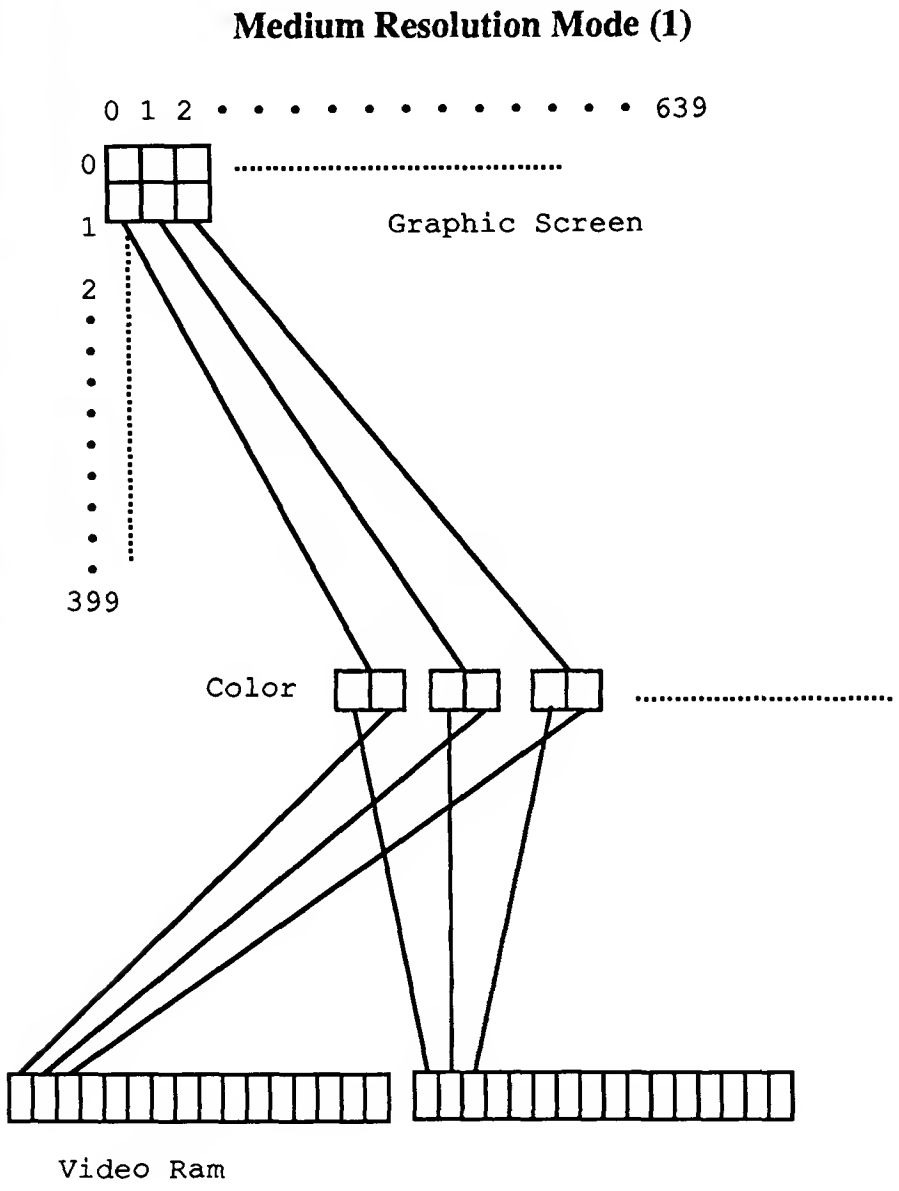

Desk File View Options
A:\
224136 bytes used in 5 items.
CONTROL PANEL
5:33 PM
5/29/85
0 1 2 3 4
Cancel

Figure 3.2-3


Medium Resolution Mode (1)
0 1 2 • • • • • • • • • • • • • 639
0
1
2
399
Graphic Screen
Color
Video Ram

You can see the results of the stretched pixels in figure 3.2-4. The letters appear to be taller than in hi-res mode.

In low-resolution mode (320x200), the ST allows up to 16 colors. This is done similarly to the medium resolution mode, but four bits are are used to represent one "point" on the screen. Four bits can contain up to 16 different values, each one representing a different color. Figure 3.2-5 illustrates how four adjacent words are used to represent one point. A "point" is stretched horizontally and vertically.

You can see the results of the stretched pixels in lo-res mode in figure 3.2-6.

Figure 3.2-4

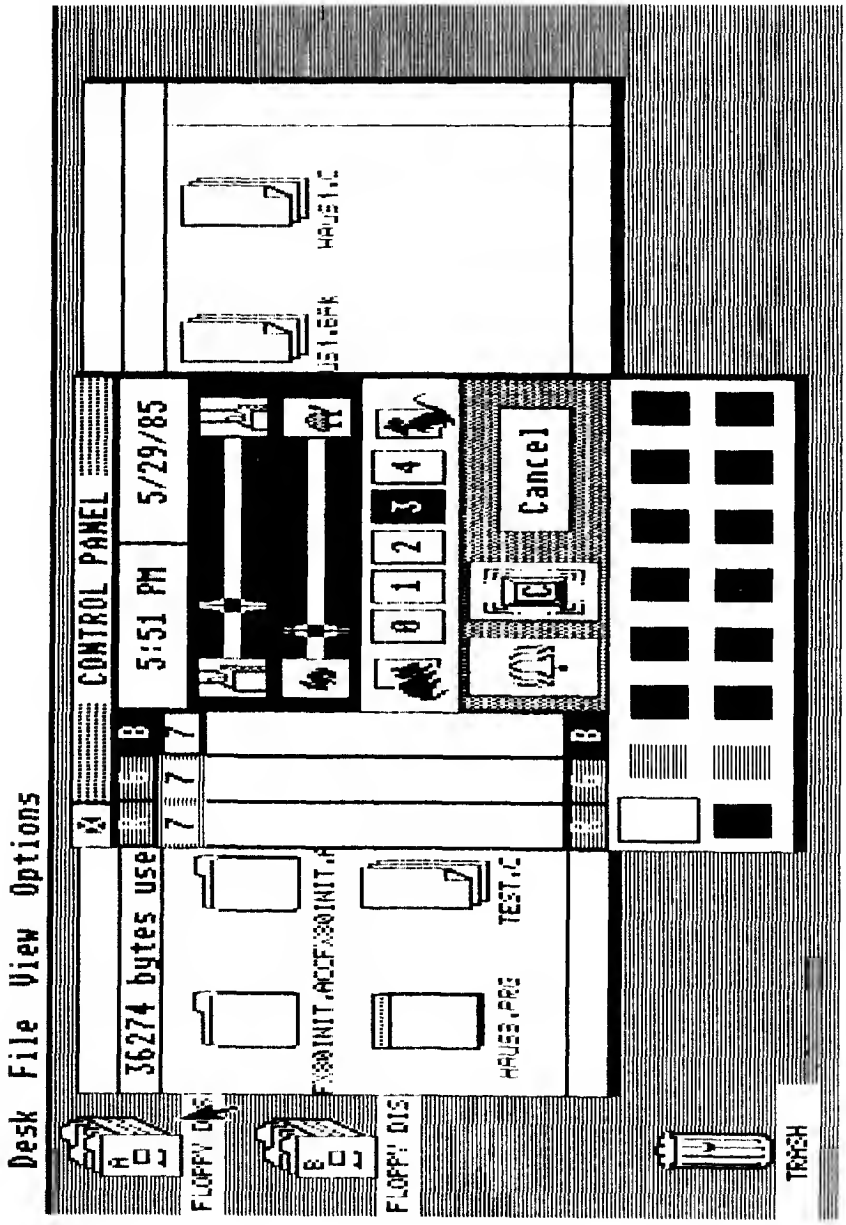

Desk File View Options
CONTROL PANEL
5:51 PM
5/29/85
36274 bytes use
Cancel
FLOPPY DISK
TRASH

Figure 3.2-5

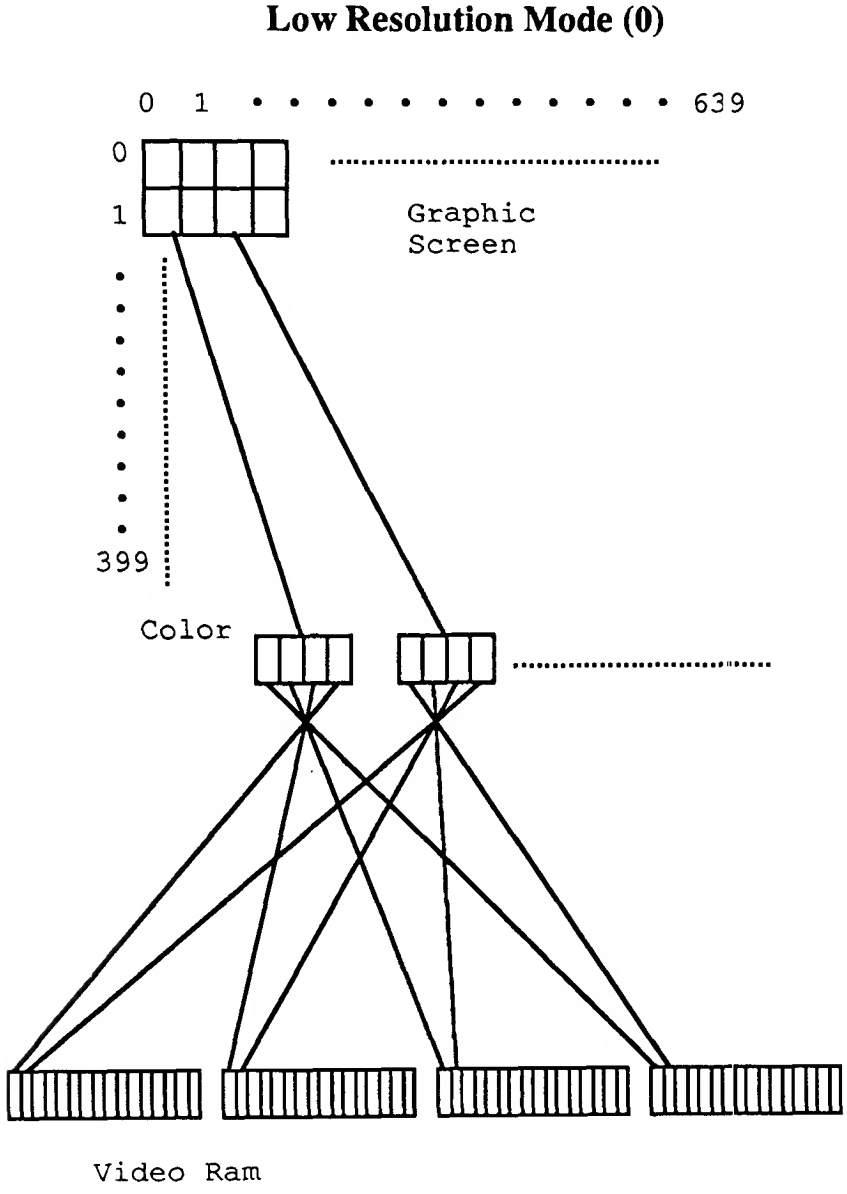
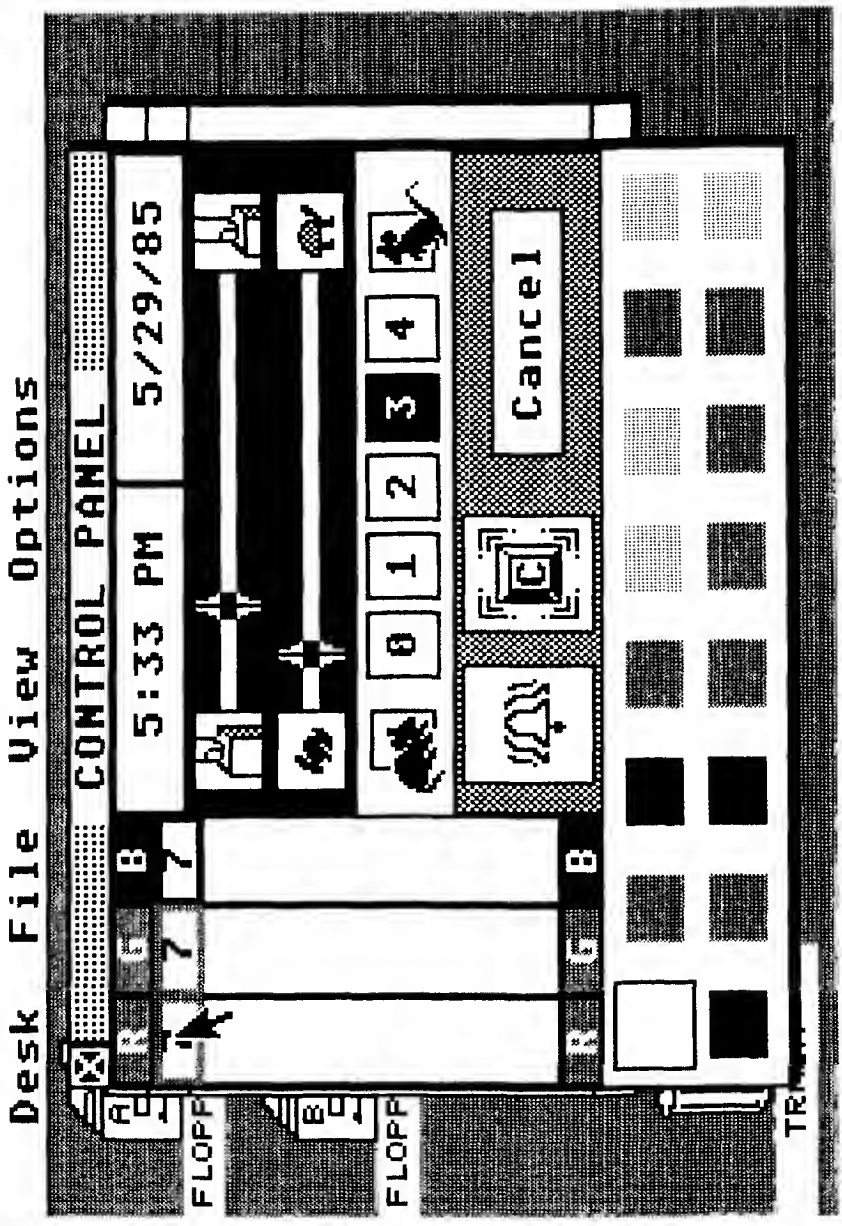

Low Resolution Mode (0)
0 1 • • • • • • • • • • • • • 639
0
1
Graphic
Screen
399
Color
Video Ram

Figure 3.2-6


Desk File View Options
CONTROL PANEL
5:33 PM
5/29/85
0 1 2 3 4
Cancel
A
B
FLOPP
FLOPP

## 3.3 Color hardcopy programs

Next we have two programs for getting hardcopy. One produces hardcopy to a color dot-matrix printer, and the other to a plotter.

We've chosen to use common peripherals. We've used Epson devices because they are readily available and reasonably priced. These routines may be adapted for other devices by changing a few constants in the program.

Both hardcopy programs are designed so they can be started simply and easily. Each copies itself behind video RAM (where there are 768 bytes free) and remains there while the ST's power is on. Hardcopy is activated by <ALT> <HELP>.

Some of the pictures reproduced in the color plate section are done with the permission of Atari Corp. Our thanks especially to Sig Hartmann.

## 3.3.1 Color dot-matrix printer hardcopy

This program was a difficult one for us to write.

First we had to decide how to represent the screen on paper. Without color, the screen appears dark while the paper is white. We decided to make light colors on the screen appear light on the paper as well. This may sometimes result in unsatisfactory pictures, as in Plate 4.

This version of the hardcopy works with an Epson JX-80, which is a color version of the popular FX-80. The JX-80 has a wide color ribbon. The three basic colors and black are organized in narrow bands on the ribbon. This yields seven colors that the printer can produce automatically. This program is limited to these seven colors.

To change the color, a motor moves the ribbon color in front of the printhead. Each screen line is scanned for a specific color and the appropriate pixels on the line are printed in this color.

If the entire 16-color spectrum of the low-resolution mode is used, the hardcopy may take considerable time to complete. For example, hardcopy in Plate 7 takes about one-half hour to complete.

Following is the assembly language listing for the color printer hardcopy:

```
*         Epson jx-80 hardcopy
*         org     $cba
gemdos    equ     1
xbios     equ     14
prchar    equ     5
sbase     equ     2
getres    equ     4
aff       equ     -2        no. colors
afc       equ     -4        color counter
pwf       equ     -6        words/pixel
hmf       equ     -8        hor multipl
vmf       equ     -10       vert multipl
zbl       equ     -14       base line
zwf       equ     -16       no. words/line
zwc       equ     -18       no. words counter
znf       equ     -20       no. points/line
znc       equ     -22       no. points counter
baf       equ     -24       vert status
zzc       equ     -26       line counter
zol       equ     -30       line offset
ab        equ     -31       even bits found
fl        equ     -32       div flags
*         bit     0         bit of corresponding color found
*         bit     1         0=test / 1=print
ctf       equ     -48       color table
maf       equ     -64       mask  no.
pflag     equ     $4ee      flag alt/help
super     equ     32        supervisor mode
stcol     equ     7         setcolor

dummy     lea     dummy,a0          dummy for dumb loader
          clr.l   -(a7)
          move.w  #super,-(a7)
          trap    #gemdos
          addq.l  #6,a7
          move.l  d0,d6
          move.w  #sbase,-(a7)
          trap    #xbios
          addq.l  #2,a7
          movea.l d0,a0
          adda.w  #$7d00,a0
          lea     (a0),a2
          lea     start(pc),a1
```

```
        move.l  #fin-start-1,d0
reloc   move.b  (a1)+,(a0)+
        dbra    d0,reloc

        movea.l $456,a0
        adda    #28,a0
        move.l  a2,(a0)
        move.l  d6,-(a7)
        move.w  #super,-(a7)
        trap    #gemdos
        addq.l  #6,a7
*       rts                     in case basic is called
        clr.l   -(a7)
        trap    #gemdos
start:
        tst     pflag           want hardcopy?
        beq     st0             yes--
        rts


*************************************************************
*                                                           *
*       parameter initialization                            *
*                                                           *
*************************************************************


st0     link    a6,#-66         ceate room for working space

        move.w  #sbase,-(a7)    get physical
        trap    #xbios          screen base
        addq.l  #2,a7
        move.l  d0,zbl(a6)
        move.w  #getres,-(a7)
        trap    #xbios
        addq.l  #2,a7
        lsl.w   #1,d0
        move.w  d0,(a6)
        lea     aft(pc),a1
        move.w  0(a1,d0.w),aff(a6)
        moveq   #1,d7           if high-res, prepare color no.
```

```
        moveq   #8,d0           and mask no.
        move.b  #7,ctf(a6)
        clr.b   ctf+1(a6)
        cmpi.w  #1,aff(a6)      hi-res ?
        beq     st52            yes
        move.w  aff(a6),d7
st1     move.w  #-1,-(a7)
        move.w  d7,-(a7)
        move.w  #stcol,-(a7)
        trap    #xbios          color to d0
        addq.l  #6,a7
        clr.w   d4
        clr.b   maf(a6,d7.w)
        move.w  d0,d1
        moveq   #2,d5
        lsl.w   #4,d1
st10    lsr.b   #4,d1
        or.b    d1,d4           hue > d4
        lsr.w   #4,d1
        dbra    d5,st10

        move.b  d4,maf(a6,d7.w)
        cmpi.b  #1,d4           black intensity under
*                               stepped?
        bls     st22            yes--
        moveq   #2,d6
        move    #$444,d5        load mask
st11    move    d5,d3
        and     d0,d3           look for highest bit
        bne     st12            found >
        lsr     #1,d5           mask set below
        dbra    d6,st11

st12    moveq   #2,d4
        clr.w   d5
st2     andi    #$7ff,d3        determine color (to d5)
        cmpi.w  #$ff,d3
        bls     st21
        bset.l  d4,d5
st21    lsl.w   #4,d3
        dbra    d4,st2

        cmpi.b  #7,d5           white?
```

```
        bne     st5             no--
        cmpi.b  #5,maf(a6,d7)   pure white?
        bhi     st5             yes--
        addq.b  #2,maf(a6,d7)   thin out mask and
st22    clr     d5              set black
st5     move.b  d5,ctf(a6,d7.w)
        cmpi.b  #6,d5           yellow?
        bne     st50            no--
        subq.b  #2,maf(a6,d7)   widen mask
st50    dbra    d7,st1

        moveq   #15,d7
st51    moveq   #8,d0
        cmpi.b  #3,maf(a6,d7)   brightness > lowest
*                               intensity?
        bls     st52            no--
        lsr     #1,d0
        cmpi.b  #6,maf(a6,d7.w) brightness > highest
*                               intensity?
        bls     st52            no--
        clr     d0
st52    move.b  d0,maf(a6,d7.w)
        dbra    d7,st51

        move.w  (a6),d0
        lea     pwt(pc),a1
        move.w  0(a1,d0.w),pwf(a6)
        lea     hmt(pc),a1
        move.w  0(a1,d0.w),hmf(a6)
        lea     vmt(pc),a1
        move.w  0(a1,d0.w),vmf(a6)
        lea     zwt(pc),a1
        move.w  0(a1,d0.w),zwf(a6)
        lea     znt(pc),a1
        move.w  0(a1,d0.w),znf(a6)
        lea     bat(pc),a1
        move.w  0(a1,d0.w),baf(a6)
        move.w  #50,zzc(a6)
        clr.b   fl(a6)
        bra     nl0
```

```
*************************************************************
*                                                           *
*       next line                                           *
*                                                           *
*************************************************************


nl:
        subq.w  #1,zzc(a6)      line counter run through?
        beq     exit            yes--
        move.l  zbl(a6),d7      line basis
        addi.l  #640,d7         to increment
        move.l  d7,zbl(a6)      a line
nl0     lea     lftab(pc),a5    linefeed
        moveq   #4,d7           on
        bsr     lf              printer
        move.w  aff(a6),afc(a6) color counter
        movea.l zbl(a6),a3      line basis
        bra     sl0


*************************************************************
*                                                           *
*       next color                                          *
*                                                           *
*************************************************************

sl:
        tst.w   pflag           hardcopy break?
        bne     exit            yes--
        subq.w  #1,afc(a6)      color counter done running?
        bmi     nl              yes-- new line
        bra     sl0
sl00    bchg.b  #1,fl(a6)       last run just a test ?
        bne     sl              no-- it was printed
        btst.b  #0,fl(a6)       point in the line  found?
        beq     sl00            no--
        lea     ctf(a6),a1
        adda.w  afc(a6),a1
        clr.w   d6
        move.b  (a1),d6
        cmpi.b  #7,d6           white?
        beq     sl00            yes-- don't print it
```

```
        lea     pre1(pc),a5     color change
        moveq   #3,d7           on
        bsr     lf              printer
        lea     ct(pc),a1
        move.b  0(a1,d6.w),d0
        bsr     chout
        lea     pre2(pc),a5
        moveq   #5,d7
        bsr     lf
sl0     move.w  zwf(a6),zwc(a6) no. of words/line
        bclr.b  #0,fl(a6)
        lea     0,a4
        move.w  afc(a6),d7      color number sought
        clr.w   d0
        move.b  maf(a6,d7.w),d0 load mask
        lea     mask(pc),a0
        move.l  0(a0,d0.w),d2
        bra     sw0

*************************************************************
*                                                           *
*       next word                                           *
*                                                           *
*************************************************************

sw:
        subq.w  #1,zwc(a6)      word counter run?
        beq     sl00            yes--
        movea.l zol(a6),a4      line offset
        adda.w  pwf(a6),a4      words/pixel
        adda.w  pwf(a6),a4      *2
sw0     move.w  #$8000,d5       bitmask for test
        move.l  a4,zol(a6)      save line offset
        bra     sb0

*************************************************************
*                                                           *
*       next bit                                            *
*                                                           *
*************************************************************

sb:
        lsr.w   #1,d5           all bits in word ready?
```

```
        beq     sw              yes--
sb0     move.w  znf(a6),znc(a6) no. of pins/line
        clr.b   d4
        movea.l zol(a6),a4
        bra     tb

*****************************************************************
*                                                               *
*       next pin                                                *
*                                                               *
*****************************************************************

bs:
        clr.l   d7
        move.w  vmf(a6),d7      vertical multiplier
        subq    #1,d7
bs0     lsl.b   #1,d4
        or.b    ab(a6),d4
        dbra    d7,bs0
        adda.w  baf(a6),a4      vertical condition of points
        subq.w  #1,znc(a6)      pin counter run?
        bne     tb              no-- test points
        tst.b   d4              a point given?
        beq     bs00            no--
        bset.b  #0,fl(a6)
bs00    btst.b  #1,fl(a6)       should it be printed?
        beq     sb              no--
        clr.l   d7
        move.w  hmf(a6),d7      horizontal multiplier
        subq    #1,d7
bs1     move.b  d4,d0
        and.b   d2,d0           byte masked
        bsr     chout           and output
        ror.l   #8,d2           rotate raster mask
        dbra    d7,bs1
        bra     sb

*****************************************************************
*                                                               *
*       test bit                                                *
*                                                               *
*****************************************************************
```

```
tb:
        clr.w   d3
        clr.l   d6
        move.w  pwf(a6),d6      words/pixel
        move.w  d6,d0
        lsl.w   #1,d0           next word
        subq.b  #1,d6
        lea     0(a3,a4),a0
        lea     0(a0,d0.w),a5
tbl     lsl.b   #1,d3           bits collected for color
*                               number
        subq.l  #2,a5
        move.w  (a5),d7
        and.w   d5,d7           bit set?
        beq     tb2             no--
        bset.l  #0,d3
tb2     dbra    d6,tbl
        clr.b   ab(a6)
        cmp.w   afc(a6),d3      color number being sought?
        bne     tb3             no--
        bset.b  #0,ab(a6)       point marked as found
tb3     bra     bs

*************************************************************
*                                                           *
*       output                                              *
*                                                           *
*************************************************************

exit:
        unlk    a6              free up workspace

        move.w  #-1,pflag       hardcopy ready
        rts

*************************************************************
*                                                           *
*       string on (a5) output with counter in d7            *
*                                                           *
*************************************************************

lf:
        andi.l  #$ffff,d7
```

```
        subq    #1,d7
lf0     move.b  0(a5,d7),d0
        bsr     chout
        dbra    d7,lf0
        rts

*************************************************************
*                                                           *
*       character in d0 to printer                          *
*                                                           *
*************************************************************

chout:
        move.w  d0,-(a7)
        move.w  #prchar,-(a7)
        trap    #gemdos
        addq.l  #4,a7
        rts

*************************************************************
*                                                           *
*       constants                                           *
*                                                           *
*************************************************************

aft     dc.w    15,3,1          no. of colors
pwt     dc.w    4,2,1           words belonging to a pixel
hmt     dc.w    2,1,1           horizontal doubling
vmt     dc.w    2,2,1           vertical doubling
zwt     dc.w    20,40,40        words/line
znt     dc.w    4,4,8           pins/line
bat     dc.w    160,160,80      vertical state of lines
mask    dc.l    $44001100       color dimming
        dc.l    $aa55aa55       averaging out from
        dc.l    -1              full
ct      dc.b    0,2,6,2,1,3,4,0 printer color
lftab   dc.b    24,"J",27,13    linefeed 8 pins
pre1    dc.b    "r",27,13       color choice
pre2    dc.b    2,128,4,"*",27  graphic mode & point counter
fin     equ     *
        .end
```

The data in the last 6 lines can be changed to adapt the program to other printers. Here you can enter the printer-specific control codes. Note that the control sequences are arranged in reverse order.

If you do not have an assembler but still want to make changes "by hand" in the BASIC program, make sure that the length and position of the strings don't change. If this happens, you'll have to change the reference addresses.

The machine language program for loading from BASIC differs slightly from the assembler version. Since the program is called with CALL, it must be terminated with RTS and not with TERM via GEMDOS.

```
5     rem BASIC loader for Epson JX-80 hardcopy
10    dim a%(415)
20    for i=0 to 415
30    read a%(i)
40    next i
50    b=varptr(a%(0))
60    call b
70    end
950   data &H42A7,&H3F3C,&H0020
960   data &H4E41,&H5C8F,&H2C00,&H3F3C,&H0002,&H4E4E,&H548F,&H2040
970   data &HD0FC,&H7D00,&H45D0,&H43FA,&H0028,&H203C,&H0000,&H02F9
980   data &H10D9,&H51C8,&HFFFC,&H2079,&H0000,&H0456,&HD0FC,&H001C
990   data &H208A,&H2F06,&H3F3C,&H0020,&H4E41,&H5C8F,&H4E75,&H4E41
1000  data &H4A79,&H0000,&H04EE,&H6702,&H4E75,&H4E56,&HFFBE,&H3F3C
1010  data &H0002,&H4E4E,&H548F,&H2D40,&HFFF2,&H3F3C,&H0004,&H4E4E
1020  data &H548F,&HE348,&H3C80,&H43FA,&H0288,&H3D71,&H0000,&HFFFE
1030  data &H7E01,&H7008,&H1D7C,&H0007,&HFFD0,&H422E,&HFFD1,&H0C6E
1040  data &H0001,&HFFFE,&H6700,&H009A,&H3E2E,&HFFFE,&H3F3C,&HFFFF
1050  data &H3F07,&H3F3C,&H0007,&H4E4E,&H5C8F,&H4244,&H4236,&H70C0
1060  data &H3200,&H7A02,&HE949,&HE809,&H8801,&HE849,&H51CD,&HFFF8
1070  data &H1D84,&H70C0,&H0C04,&H0001,&H633A,&H7C02,&H3A3C,&H0444
1080  data &H3605,&HC640,&H6606,&HE24D,&H51CE,&HFFF6,&H7802,&H4245
1090  data &H0243,&H07FF,&H0C43,&H00FF,&H6302,&H09C5,&HE94B,&H51CC
1100  data &HFFF0,&H0C05,&H0007,&H660E,&H0C36,&H0005,&H70C0,&H6206
1110  data &H5436,&H70C0,&H4245,&H1D85,&H70D0,&H0C05,&H0006,&H6604
1120  data &H5536,&H70C0,&H51CF,&HFF86,&H7E0F,&H7008,&H0C36,&H0003
1130  data &H70C0,&H630C,&HE248,&H0C36,&H0006,&H70C0,&H6302,&H4240
1140  data &H1D80,&H70C0,&H51CF,&HFFE4,&H3016,&H43FA,&H01CA,&H3D71
1150  data &H0000,&HFFFA,&H43FA,&H01C6,&H3D71,&H0000,&HFFF8,&H43FA
1160  data &H01C2,&H3D71,&H0000,&HFFF6,&H43FA,&H01BE,&H3D71,&H0000
1170  data &HFFF0,&H43FA,&H01BA,&H3D71,&H0000,&HFFEC,&H43FA,&H01B6
1180  data &H3D71,&H0000,&HFFE8,&H3D7C,&H0032,&HFFE6,&H422E,&HFFE0
1190  data &H6016,&H536E,&HFFE6,&H6700,&H014C,&H2E2E,&HFFF2,&H0687
```

```
1200  data &H0000,&H0280,&H2D47,&HFFF2,&H4BFA,&H01A4,&H7E04,&H6100
1210  data &H0140,&H3D6E,&HFFFE,&HFFFC,&H266E,&HFFF2,&H6054,&H4A79
1220  data &H0000,&H04EE,&H6600,&H011E,&H536E,&HFFFC,&H6BC4,&H6042
1230  data &H086E,&H0001,&HFFE0,&H66E6,&H082E,&H0000,&HFFE0,&H67F0
1240  data &H43EE,&HFFD0,&HD2EE,&HFFFC,&H4246,&H1C11,&H0C06,&H0007
1250  data &H67DE,&H4BFA,&H015E,&H7E03,&H6100,&H00F6,&H43FA,&H0148
1260  data &H1031,&H6000,&H6100,&H00FE,&H4BFA,&H014B,&H7E05,&H6100
1270  data &H00E0,&H3D6E,&HFFF0,&HFFEE,&H08AE,&H0000,&HFFE0,&H49F9
1280  data &H0000,&H0000,&H3E2E,&HFFFC,&H4240,&H1036,&H70C0,&H41FA
1290  data &H010A,&H2430,&H0000,&H6012,&H536E,&HFFEE,&H6792,&H286E
1300  data &HFFE2,&HD8EE,&HFFFA,&HD8EE,&HFFFA,&H3A3C,&H8000,&H2D4C
1310  data &HFFE2,&H6004,&HE24D,&H67E0,&H3D6E,&HFFEC,&HFFEA,&H4204
1320  data &H286E,&HFFE2,&H6044,&H4287,&H3E2E,&HFFF6,&H5347,&HE30C
1330  data &H882E,&HFFE1,&H51CF,&HFFF8,&HD8EE,&HFFE8,&H536E,&HFFEA
1340  data &H6628,&H4A04,&H6706,&H08EE,&H0000,&HFFE0,&H082E,&H0001
1350  data &HFFE0,&H67C0,&H4287,&H3E2E,&HFFF8,&H5347,&H1004,&HC002
1360  data &H6162,&HE09A,&H51CF,&HFFF6,&H60AA,&H4243,&H4286,&H3C2E
1370  data &HFFFA,&H3006,&HE348,&H5306,&H41F3,&HC000,&H4BF0,&H0000
1380  data &HE30B,&H558D,&H3E15,&HCE45,&H6704,&H08C3,&H0000,&H51CE
1390  data &HFFF0,&H422E,&HFFE1,&HB66E,&HFFFC,&H6606,&H08EE,&H0000
1400  data &HFFE1,&H6082,&H4E5E,&H33FC,&HFFFF,&H0000,&H04EE,&H4E75
1410  data &H0287,&H0000,&HFFFF,&H5347,&H1035,&H7000,&H6106,&H51CF
1420  data &HFFF8,&H4E75,&H3F00,&H3F3C,&H0005,&H4E41,&H588F,&H4E75
1430  data &H000F,&H0003,&H0001,&H0004,&H0002,&H0001,&H0002,&H0001
1440  data &H0001,&H0002,&H0002,&H0001,&H0014,&H0028,&H0028,&H0004
1450  data &H0004,&H0008,&H00A0,&H00A0,&H0050,&H4400,&H1100,&HAA55
1460  data &HAA55,&HFFFF,&HFFFF,&H0002,&H0602,&H0103,&H0400,&H184A
1470  data &H1B0D,&H721B,&H0D02,&H8004,&H2A1B
```

## 3.3.2 Color plotter hardcopy

Hardcopy to a plotter is quite different than hardcopy to a dot-matrix printer.

While it's possible to draw point by point with the dot-matrix printer, the method is really not practical with a plotter. By nature of its construction, a plotter is suited to drawing lines. How do we write a program to make the plotter draw actual lines, rather than a series of points?

We can distinguish a line on the screen because of our familiarity with them as geometric forms. But a program recognizes a line only as a set of points. The programming objective is to make the computer recognize points that belong together, and then draw them as a curve or line.

Our program uses the following method to accomplish this "point-to-line" conversion:

When a point is found, we lower the pen and then turn a quarter of a rotation to the left (in screen memory) to see if a point is set there. If not, we rotate right (in screen memory) in eigths of a step to search for points in these directions. If we find a point, we move the pen to it, and start the procedure all over again. This continues until there is no bordering point is found at the current location.

This complex-sounding procedure has the effect that all the contours of larger objects are traced. This is important for the appearance of the finished picture. You can clearly see this effect in the unfinished picture of figure 3.3.2-2.

This procedure has a disadvantage. After a point is found, it is removed from the screen, so that in later searches it is no longer recognized. Consequently, this procedure destroys the screen image. But it allows you to follow the program's progress on the screen.

Figure 3.3.2-1

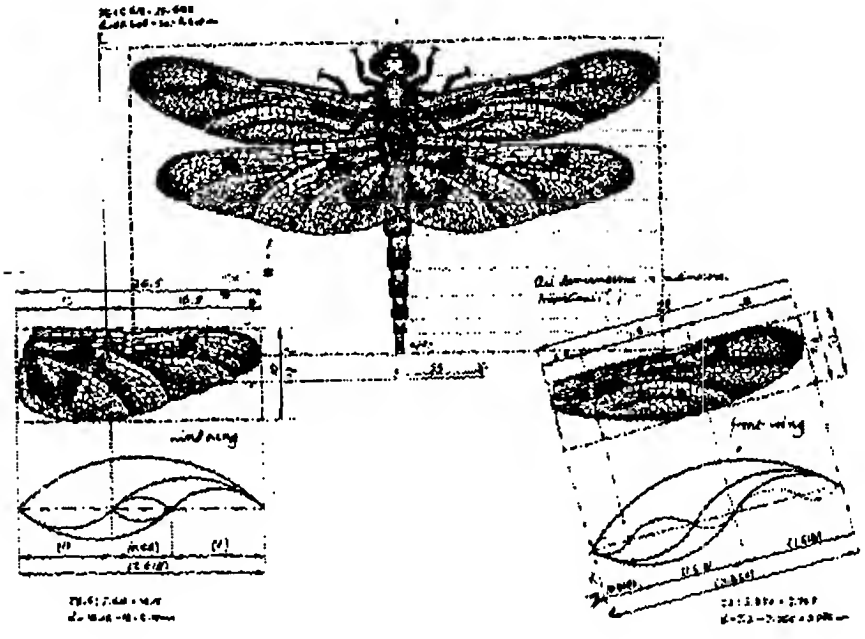
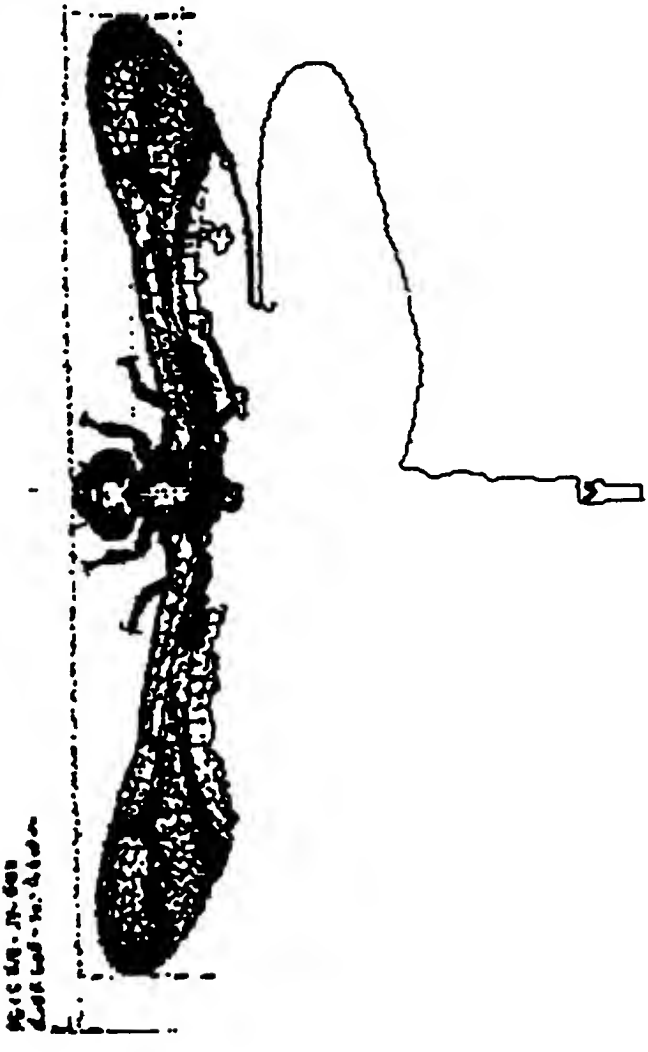


Figure 3.3.2-2



When the hardcopy is completed, the screen is completely white. Therefore, make sure that your picture is saved, otherwise it will be destroyed.

The program is designed for the Epson HI-80 plotter. You can easily adapt it for other plotters, since the command language is completely parameterized.

The operation of the program takes longer than for the dot-matrix printer hardcopy. To allow for change of pens, for more than four colors, the plotter stops at the next color change after you press <ALT> <HELP> keys. Once you've changed the pens, press <ALT> <HELP> again to continue.

The results are seen in Plate 6. Compare this with Plate 5. You can clearly see the limits of a plotter with multicolor use.

In contrast to the dot-matrix printer hardcopy, Plate 7, the color of the background is ignored. It is always white.

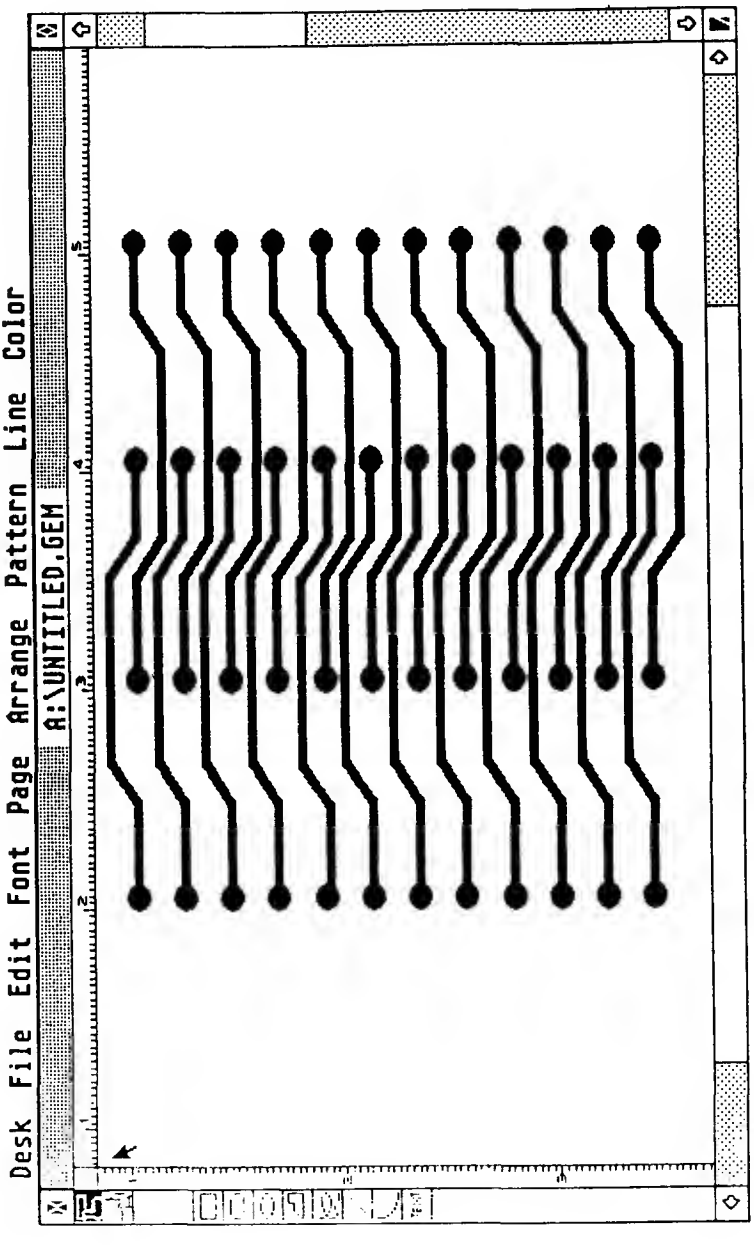
You can stop the current color output by pressing <ALT> <HELP> three times.

In Plate 8 you see a peculiarity of plotter hardcopy. In medium resolution mode, the vertical dimesion becomes distorted, because a single "point" on the screen is actually two pixels. But since this program doesn't correspond with this, the picture becomes compressed. You may also notice the text is in German, TOS is easily configured for foregin languages.

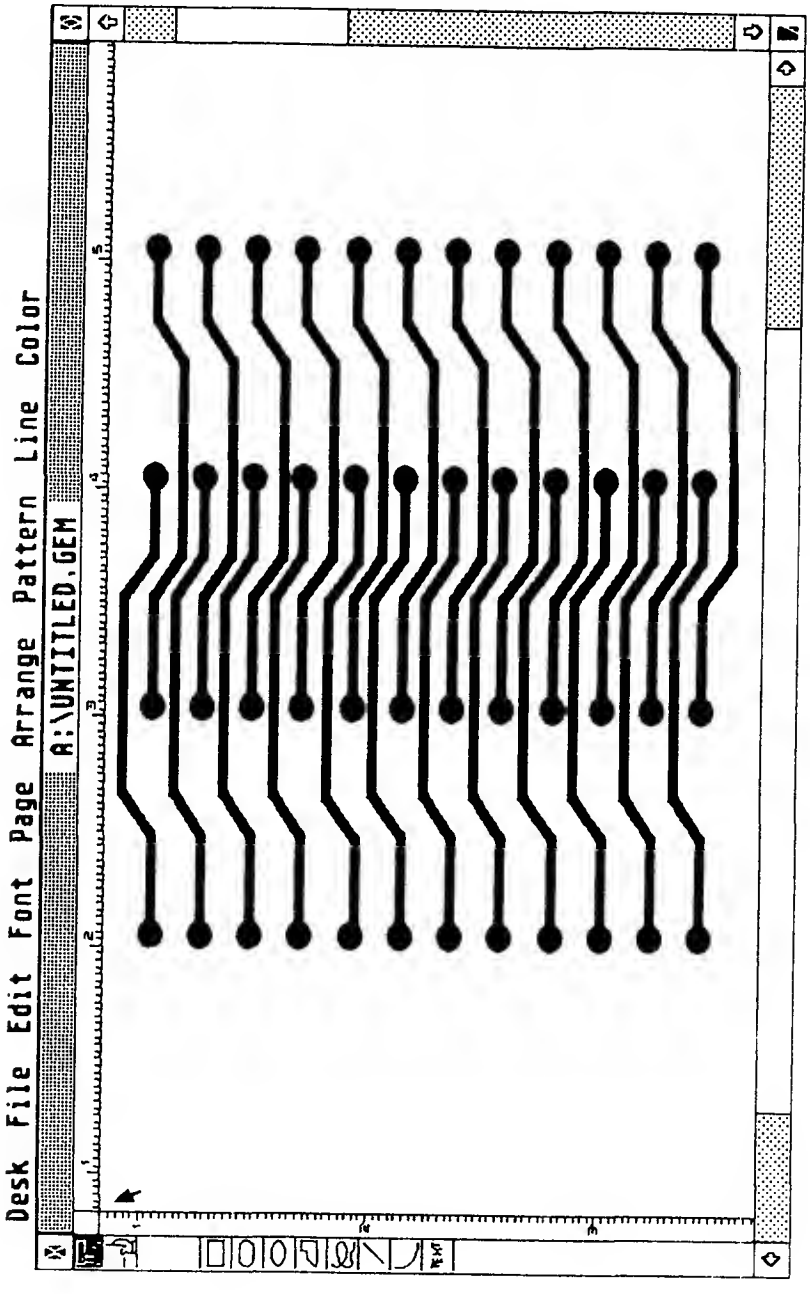
Figure 3.3.2-3, dot-matrix hardcopy, and figure 3.3.2-4, plotter hardcopy, show the difference in results. Notice that diagonal lines are smoother on the plotter hardcopy.

The assembly language listing follows.

Figures 3.3.2-3



Figures 3.3.2-4



```
*       Epson HI-80 plotter hardcopy
*        org     $cba
gemdos  equ     1
bios    equ     13
xbios   equ     14
bconout equ     3
prt     equ     0
phybas  equ     2
setscr  equ     5
super   equ     32
intin   equ     8
ptsin   equ     12
wrmod   equ     36
init    equ     $a000
setpix  equ     $a001
getpix  equ     $a002
yko     equ     2
pflag   equ     $4ee            flag alt/help
apix    equ     -4              total no. of pixels
pscalx  equ     -6              factor x
pscaly  equ     -8              factor y
adir    equ     -10             precise direction
pdir    equ     -12             orig. direction
maxx    equ     -14             number of x pixels
maxy    equ     -16             number of y pixels
ccol    equ     -18             precise color number
acol    equ     -20             number of colors
comma   equ     -22             comma w/ draw


*************************************************************
*                                                           *
*       program moves behind video ram                      *
*                                                           *
*************************************************************

dummy   lea     dummy,a0        dummy for dumb loader
        clr.l   -(a7)           set up
        move.w  #super,-(a7)    a privileged
        trap    #gemdos         regis-
        addq.l  #6,a7           ter
        move.l  d0,d6
        move.w  #phybas,-(a7)   program start
```

```
        trap    #xbios          is
        addq.l  #2,a7           video-basis
        movea.l d0,a0           +
        adda.w  #$7d00,a0       length of
        lea     (a0),a2         video-ram
        lea     start(pc),a1
        move.l  #fin-start-1,d0 load counter
reloc   move.b  (a1)+,(a0)+     move
        dbra    d0,reloc        program

        movea.l $456,a0         program hooks up
        adda    #28,a0          to the
        move.l  a2,(a0)         vblank-queue
        move.l  d6,-(a7)        priv.-
        move    #super,-(a7)    status
        trap    #gemdos         re-
        addq.l  #6,a7           turns
*       rts                     if called from basic
        clr     -(a7)
        trap    #gemdos         terminate
start:
        tst     pflag           hardcopy desired?
        beq     param           yes--
        rts


*****************************************************
*                                                   *
*       parameter initialization                    *
*                                                   *
*****************************************************

param   move    #phybas,-(a7)   get physical
        trap    #xbios          screen
        addq.l  #2,a7           basis
        move    #-1,-(a7)       and
        move.l  d0,-(a7)        match
        move.l  d0,-(a7)        with
        move    #setscr,-(a7)   logical
        trap    #xbios          basis
        adda.l  #12,a7
        dc.w    init            get screen parameters
        link    a6,#-24         make room for work register
```

```
        movea.l intin(a0),a3
        movea.l ptsin(a0),a4
        clr     wrmod(a0)       set write mode
        move    (a0),d7         no. of planes
        andi    #6,d7
        lea     scalx(pc),a0
        move    0(a0,d7),pscalx(a6)
        lea     scaly(pc),a0
        move    0(a0,d7),pscaly(a6)
        lea     max(pc),a0
        move    0(a0,d7),maxx(a6)
        lea     may(pc),a0
        move    0(a0,d7),maxy(a6)
        lea     colc(pc),a0
        move    0(a0,d7),acol(a6)
        move    maxx(a6),d6
        mulu    maxy(a6),d6
        move.l  d6,apix(a6)
        move    #1,ccol(a6)     color no. 1
init1   cmpi    #1,pflag        stop for color choice?
        bne     init3           no--
        bsr     caps
init2   cmpi    #2,pflag        go on?
        bne     init2           no--
        clr     pflag
init3   bsr     setcol          color choice
        bsr     home            plotter in output state
        pea     -1              search begins at upper left


*****************************************************************
*                                                               *
*       look for first pixel in a line                          *
*                                                               *
*****************************************************************

srch    move.l  (a7)+,d7
        addq.l  #1,d7
        cmp.l   apix(a6),d7     all pixels viewed?
        beq     exit            yes--
        move.l  d7,-(a7)        save current position
        bsr     chkpix          look for next point
```

```
        cmp     ccol(a6),d0     looked for color?
        bne     srch            no--
        move    #3,adir(a6)     search direction is right


*************************************************************
*                                                           *
*       draw connected points                               *
*                                                           *
*************************************************************

plot    bsr     mov             plotter to new position
        bsr     pendwn          pen down
        bsr     erase           clear point found
plot1   clr     d0
        bsr     nexpix          look for a connected point

        tst     d0              past color found?
        bne     plot2           yes--
        bsr     outcr           delimiter output
        bsr     penup           pen up
        bra     srch
plot2   bsr     draw            lines to next point
        bsr     erase           clear point drawn
        bra     plot1           look for next point


*************************************************************
*                                                           *
*       look for next connected point                       *
*                                                           *
*************************************************************

nexpix  subq    #2,adir(a6)     1/4-turn left
        andi    #7,adir(a6)     0-7 only allowed
        move    adir(a6),pdir(a6) mark output direction
        bra     nex3
nex1    movem   (a7)+,d3-d4     get old coordinates
        addq    #1,adir(a6)     1/8-turn right
        andi    #7,adir(a6)     only 0-7 allowed
        move    pdir(a6),d7
        cmp     adir(a6),d7     output point again?
        bne     nex3            no--
```

```
        clr     d0
        rts
nex3    move    adir(a6),d7     jump
        lsl     #1,d7           dependent upon
        lea     j(pc),a0        direction
        adda    0(a0,d7),a0     save previous
        movem   d3-d4,-(a7)     coordinates
        jsr     (a0)            jump
        cmp     ccol(a6),d0     past colors found?
        bne     nex1            no-look in another direction

        addq.l  #4,a7           correct stack
        rts                     connect the dots


*****************************************************************
*                                                               *
*       direction-dependent jumps                               *
*                                                               *
*****************************************************************

j       dc.w    re-j,ru-j,un-j,lu-j,li-j,lo-j,ob-j,ro-j

re      addq    #1,d3           right
        cmp     maxx(a6),d3     reached end-of-line?
        bcs     askpix          no--
        rts

ru      addq    #1,d3           lower right
        cmp     maxx(a6),d3     end-of-line?
        bcs     un              no--
        rts

un      addq    #1,d4           bottom
        cmp     maxy(a6),d4     end-of-screen?
        bcs     askpix          no--
        rts

lu      addq    #1,d4           lower left
        cmp     maxy(a6),d4     end-of-screen?
        bcs     li              no--
        rts
```

```
li      subq    #1,d3           left
        bpl     askpix          still no end
        rts

lo      subq    #1,d3           upper left
        bpl     ob              still no end
        rts

ob      subq    #1,d4           top
        bpl     askpix          still no end
        rts

ro      subq    #1,d4           upper right
        bpl     re              still no end
        rts


*************************************************************
*                                                           *
*       test for set pixels                                 *
*                                                           *
*************************************************************

chkpix  divu    maxx(a6),d7     convert
        move    d7,d4           d7 to
        swap    d7              y
        move    d7,d3           and x
askpix  cmpi    #3,pflag        ruin the color?
        bcs     ask1            no--
        move    #1,pflag        eventual pen change enabled
        bra     exit            color ready  >
ask1    move    d3,(a4)         coordinates
        move    d4,yko(a4)      loaded
        dc.w    getpix          line a  reads point
        rts


*************************************************************
*                                                           *
*       pixel cleared                                       *
*                                                           *
*************************************************************
```

```
erase   move    d3,(a4)         load coordinates
        move    d4,yko(a4)
        clr     (a3)            colro 0
        dc.w    setpix          line a sets point
        rts


*************************************************************
*                                                           *
*       diverse output-routines                             *
*                                                           *
*************************************************************

home    lea     hm(pc),a2        plotter in home position

        bra     outstrx

setcol  lea     scols(pc),a2    color put in from ccol
        bsr     outstrx
        lea     scoln(pc),a2
        move    ccol(a6),d7
        move.b  -1(a2,d7),d0
        bsr     outchr
        bra     outcr

penup   lea     pup(pc),a2      pen up
        bra     outstrx

pendwn  clr     comma(a6)       pen down
        lea     pdw(pc),a2
        bra     outstrx

mov     lea     mv(pc),a2       positioning w/o pen
        bsr     outstrx
        bsr     outcor
        bra     outcr

draw    tst     comma(a6)       positioning w/ pen
        bne     draw1
        st      comma(a6)
        lea     dr(pc),a2
        bsr     outstrx
        bra     outcor
```

```
draw1   bsr     outcom

outcor  move    d3,d6           coord pair output as ascii

        mulu    pscalx(a6),d6
        bsr     outw
        bsr     outcom          output comma
        move    maxy(a6),d7     reversal of
        sub     d4,d7           y-coordinate
        move    d7,d6
        mulu    pscaly(a6),d6

outw    move.l  #1000,d7        hex no. in d6 output as ascii

outw1   andi.l  #$3fff,d6
        divu    d7,d6
outw3   move    d6,d0
        ori     #48,d0
        bsr     outchr
        swap    d6
outw4   divu    #10,d7
        bne     outw1
        rts

outstrx clr     d2          string output (counter-1 on (a2))
        move.b  (a2)+,d2
outstr  move.b  (a2)+,d0        string in (a2) output
*                               (counter in d2)
        bsr     outchr
        dbra    d2,outstr
        rts

caps    lea     cap(pc),a2
        bsr     outstrx

outcr   move    #13,d0          c/r
        bra     outchr

outcom  move    #44,d0          comma

outchr  movem.l d0-d2/a0-a2,-(a7)
        andi    #255,d0
        move    d0,-(a7)        character in d0
```

```
        move    #prt,-(a7)      output to
        move    #bconout,-(a7)  printer
        trap    #bios
        addq.l  #6,a7
        movem.l (a7)+,d0-d2/a0-a2
        rts

*****************************************************************
*                                                               *
*       output                                                  *
*                                                               *
*****************************************************************

exit    addq    #1,ccol(a6)     color sought +1
        move    acol(a6),d7
        cmp     ccol(a6),d7     all colors utilized?
        bpl     init1           no--
exitx   unlk    a6              free up reserved space
        move    #-1,pflag       hardcopy-flag cleared
        bsr     home            plotter in home position
        bra     caps            pen tip

*****************************************************************
*                                                               *
*       constants                                               *
*                                                               *
*****************************************************************

scalx   dc.w    4,4,4           x factors
scaly   dc.w    4,4,4           y factors
max     dc.w    640,640,320     number of x pixels
may     dc.w    400,200,200     number of y pixels
colc    dc.w    1,3,15          number of colors
mv      dc.b    1,"MA"          move absolute
cap     dc.b    3,"SP-1"        pen change
pup     dc.b    5,"MR0,0",13    move relative(pen up)
pdw     dc.b    5,"DR0,0",13    draw relative(pen down)
dr      dc.b    1,"DA"          draw absolute
hm      dc.b    3,13,"HO",13    home position state
scols   dc.b    1,"SP"          color change
scoln   dc.b    "123412341234123"
fin     equ     *
        .end
```

You can adapt the program to a different plotter. The commands for the HI-80 plotter are defined in the last section under `constants`, and can be easily adapted for another plotter.

`scalx` and `scaly` specify the number of steps the plotter will make for a point on the screen. The number of steps depends on the thickness of the pen. In this example, the pen thickness is 0.4 mm.

Here's the equivalent BASIC loader:

```
5     rem BASIC loader for plotter hardcopy
10    dim a%(411)
20    for i=0 to 411
30    read a%(i)
40    next i
50    b=varptr(a%(0))
60    call b
70    end
950   data &H42A7,&H3F3C,&H0020
960   data &H4E41,&H5C8F,&H2C00,&H3F3C,&H0002,&H4E4E,&H548F,&H2040
970   data &HD0FC,&H7D00,&H45D0,&H43FA,&H0028,&H203C,&H0000,&H02F1
980   data &H10D9,&H51C8,&HFFFC,&H2079,&H0000,&H0456,&HD0FC,&H001C
990   data &H208A,&H2F06,&H3F3C,&H0020,&H4E41,&H5C8F,&H4E75,&H4E41
1000  data &H4A79,&H0000,&H04EE,&H6702,&H4E75,&H3F3C,&H0002,&H4E4E
1010  data &H548F,&H3F3C,&HFFFF,&H2F00,&H2F00,&H3F3C,&H0005,&H4E4E
1020  data &HDFFC,&H0000,&H000C,&HA000,&H4E56,&HFFE8,&H2668,&H0008
1030  data &H2868,&H000C,&H4268,&H0024,&H3E10,&H0247,&H0006,&H41FA
1040  data &H0264,&H3D70,&H7000,&HFFFA,&H41FA,&H0260,&H3D70,&H7000
1050  data &HFFF8,&H41FA,&H025C,&H3D70,&H7000,&HFFF2,&H41FA,&H0258
1060  data &H3D70,&H7000,&HFFF0,&H41FA,&H0254,&H3D70,&H7000,&HFFEC
1070  data &H3C2E,&HFFF2,&HCCEE,&HFFF0,&H2D46,&HFFFC,&H3D7C,&H0001
1080  data &HFFEE,&H0C79,&H0001,&H0000,&H04EE,&H6614,&H6100,&H01CE
1090  data &H0C79,&H0002,&H0000,&H04EE,&H66F6,&H4279,&H0000,&H04EE
1100  data &H6100,&H012C,&H6100,&H0120,&H4879,&HFFFF,&HFFFF,&H2E1F
1110  data &H5287,&HBEAE,&HFFFC,&H6700,&H01CC,&H2F07,&H6100,&H00D2
1120  data &HB06E,&HFFEE,&H66E8,&H3D7C,&H0003,&HFFF6,&H6100,&H012C
1130  data &H6100,&H011E,&H6100,&H00E4,&H4240,&H6118,&H4A40,&H660A
1140  data &H6100,&H0180,&H6100,&H0104,&H60C4,&H6100,&H0118,&H6100
1150  data &H00CA,&H60E4,&H556E,&HFFF6,&H026E,&H0007,&HFFF6,&H3D6E
1160  data &HFFF6,&HFFF4,&H601C,&H4C9F,&H0018,&H526E,&HFFF6,&H026E
1170  data &H0007,&HFFF6,&H3E2E,&HFFF4,&HBE6E,&HFFF6,&H6604,&H4240
1180  data &H4E75,&H3E2E,&HFFF6,&HE34F,&H41FA,&H0016,&HD0F0,&H7000
1190  data &H48A7,&H1800,&H4E90,&HB06E,&HFFEE,&H66CA,&H588F,&H4E75
1200  data &H0010,&H001A,&H0024,&H002E,&H0038,&H003E,&H0044,&H004A
1210  data &H5243,&HB66E,&HFFF2,&H6542,&H4E75,&H5243,&HB66E,&HFFF2
1220  data &H6502,&H4E75,&H5244,&HB86E,&HFFF0,&H652E,&H4E75,&H5244
```

```
1230  data &HB86E,&HFFF0,&H6502,&H4E75,&H5343,&H6A1E,&H4E75,&H5343
1240  data &H6A02,&H4E75,&H5344,&H6A12,&H4E75,&H5344,&H6AC2,&H4E75
1250  data &H8EEE,&HFFF2,&H3807,&H4847,&H3607,&H0C79,&H0003,&H0000
1260  data &H04EE,&H650C,&H33FC,&H0001,&H0000,&H04EE,&H6000,&H00D6
1270  data &H3883,&H3944,&H0002,&HA002,&H4E75,&H3883,&H3944,&H0002
1280  data &H4253,&HA001,&H4E75,&H45FA,&H0113,&H6000,&H0082,&H45FA
1290  data &H0110,&H6100,&H007A,&H45FA,&H010B,&H3E2E,&HFFEE,&H1032
1300  data &H70FF,&H6100,&H0084,&H6000,&H007A,&H45FA,&H00DE,&H605E
1310  data &H426E,&HFFEA,&H45FA,&H00DB,&H6054,&H45FA,&H00C6,&H614E
1320  data &H6116,&H605E,&H4A6E,&HFFEA,&H660C,&H50EE,&HFFEA,&H45FA
1330  data &H00C8,&H613A,&H6002,&H614E,&H3C03,&HCCEE,&HFFFA,&H610E
1340  data &H6144,&H3E2E,&HFFF0,&H9E44,&H3C07,&HCCEE,&HFFF8,&H2E3C
1350  data &H0000,&H03E8,&H0286,&H0000,&H3FFF,&H8CC7,&H3006,&H0040
1360  data &H0030,&H6124,&H4846,&H8EFC,&H000A,&H66E8,&H4E75,&H4242
1370  data &H141A,&H101A,&H6112,&H51CA,&HFFFA,&H4E75,&H45FA,&H0067
1380  data &H61EC,&H700D,&H6002,&H702C,&H48E7,&HE0E0,&H0240,&H00FF
1390  data &H3F00,&H3F3C,&H0000,&H3F3C,&H0003,&H4E4D,&H5C8F,&H4CDF
1400  data &H0707,&H4E75,&H526E,&HFFEE,&H3E2E,&HFFEC,&HBE6E,&HFFEE
1410  data &H6A00,&HFDF0,&H4E5E,&H33FC,&HFFFF,&H0000,&H04EE,&H6100
1420  data &HFF26,&H60B8,&H0004,&H0004,&H0004,&H0004,&H0004,&H0004
1430  data &H0280,&H0280,&H0140,&H0190,&H00C8,&H00C8,&H0001,&H0003
1440  data &H000F,&H014D,&H4103,&H5350,&H2D31,&H054D,&H5230,&H2C30
1450  data &H0D05,&H4452,&H302C,&H300D,&H0144,&H4103,&H0D48,&H4F0D
1460  data &H0153,&H5031,&H3233,&H3431,&H3233,&H3431,&H3233,&H3431
1470  data &H3233
```

# Chapter 4

# The GEM programming environment

## The GEM programming environment

GEM is designed to be an easy-to-use interface between the user and the ST. Additionally, GEM is designed to provide a convenient means for the programmer writing applications for the ST itself.

In principle, it is simpler and faster to write a program for the ST than to write a program for a different computer. GEM contains dozens of subroutines which perform a variety of powerful functions. The programmer can use these routines simply by including them in his application.

Designing applications for the ST is quite different than designing them for other computers.The programmer is responsible for maintaining the work station, window management, mouse and keyboard inputs, etc. Most ST programmers build their own collection of subroutines into a library to handle their programming housekeeping chores.

Next we'll introduce you to several GEM routines that each application may use. We'll also describe how accessories and applications may be developed.

## 4.1 Inside GEM

GEM is the graphics-oriented interface that makes the ST so easy to use . A user takes for granted the enormous complexity of this operating system that isolates him from the details of mouse control, icon structure, drop-down menu construction or window manipulation. He need not be concerned with the technical aspects of the ST.

How long would it take a programmer to produce an application if he had to write his own routines for all these tasks?

GEM's routines relieve the programmer of many of the repetitive details of using the ST. Most of the programming languages available for the ST offer libraries that provide access to GEM. The naming conventions are more or less uniform for the programming languages—allowing a programmer to easily move to a different language if he wants.

GEM has simple routines for performing data input and output, and complex routines for managing dialog boxes.

The two main parts of GEM are the VDI, or Virtual Device Interface, and the AES, or Application Environment Services.

The VDI provides services for the hardware components of the computer. It handles all the device-specific details, such as converting coordinates for screen output or printer output, providing the graphics primitives such as line, circle or fill, or writing text to a disk file.

The AES handles the "larger" tasks such as windows, drop-down menus and icons. It is responsible for controlling the mouse and keyboard input. The AES also handles *multi-tasking* operations. You may recall that the print spooler and clock display run concurrently while another application is active. These are multi-tasking operations.

## 4.1.1 The Virtual Device Interface

The VDI consists of two parts:

- the GDOS, or Graphics Device Operating System, which contains a number of the device-independent graphics routines
- the GIOS, or Graphics Input/Output System, which contains the device-specific routines and fonts for performing input and output.

The VDI recognizes two coordinate systems:

- NDC — or normalized device coordinates
- RC — or raster coordinates

Raster coordinates correspond to the physical points on a device. On the ST screen, these range from 320x200 through 640x400. On a plotter, they measure the x and y steps.

Normalized device coordinates refer to an idealized screen surface.The NDC orientation corresponds to our usual Cartesian system: point 0,0 lies at the lower left corner, and the largest values for x and y lie at the upper right corner of the drawing surface. The range of values for the NDC is from 0, 0 to 32767, 32767, and corresponds to a geometrically correct screen with very high resolution.

The programmer can select the coordinate system he wants to use. If you use the NDC, the GDOS converts the coordinates to the appropriate raster coordinates. Thus, if you ask to draw a square of 100 units, it appears square on the display. If you use RC, the coordinates are not converted. You yourself are responsible for making the object appear square.

The major advantage of using the NDC is that graphics can be exchanged between different peripheral devices. For example, the display screen has an aspect ratio of 1: 1.8. A square on the display screen is actually 1" x 1.8". If this picture is sent to a printer using raster coordinates, the square will no longer appear square on the hardcopy. Using the NDC, the square will appear correctly on the hardcopy.

The VDI makes the necessary conversions. Graphics of any type appear on any peripheral device in the proper ratio. The disadvantage of NDC is that it takes much longer to convert a graphic point to the coordinate system,

compared to the speed of raster coordinates. For this reason it is advisable to work with the RC. However, the RC requires you to be more meticulous when writing programs to ensure they remain portable.

### 4.1.2 The Application Environment Services

The AES is composed of several parts:

- the subroutine libraries
- the dispatcher
- the shell
- the desk accessory buffer
- the menu/alarm buffer

The menu/alarm buffer makes possible the fast operation of GEM. For example, the menu data buffer stores the part of the screen that is overlaid by a drop-down menu. After using the drop-down menu, a subroutine of the AES restores the desktop at lightning speed. Neither the application nor the programmer need be concerned with these details. As long as there is enough memory to save one-fourth of the screen contents, the AES can perform its tasks.

The desk accessory buffer is used similarly. In addition to data, utility programs such as `PRINIT` (the Print Initialize utility in this section) can be stored in the desk accessory buffer.

The dispatcher makes it possible for the ST to process several tasks simultaneously. "Simultaneous" is a relative term—for us it means at apparently the same time.

To conserve valuable processing time, the dispatcher has two lists. The first is the *ready list*, in which all the currently-running programs are listed and are waiting for a CPU assignment. The other is the *not ready list*, in which all processes which are waiting for a certain event to occur are listed.

Such an event could be:

- a keypress
- pressing a mouse button
- a mouse movement
- a report
- the elapse of a time interval

Thus our printer initialization utility is first put on the *not ready list* and waits until the desk accessory `FXINIT` (FX-80 Initialize) is called to install the utility.

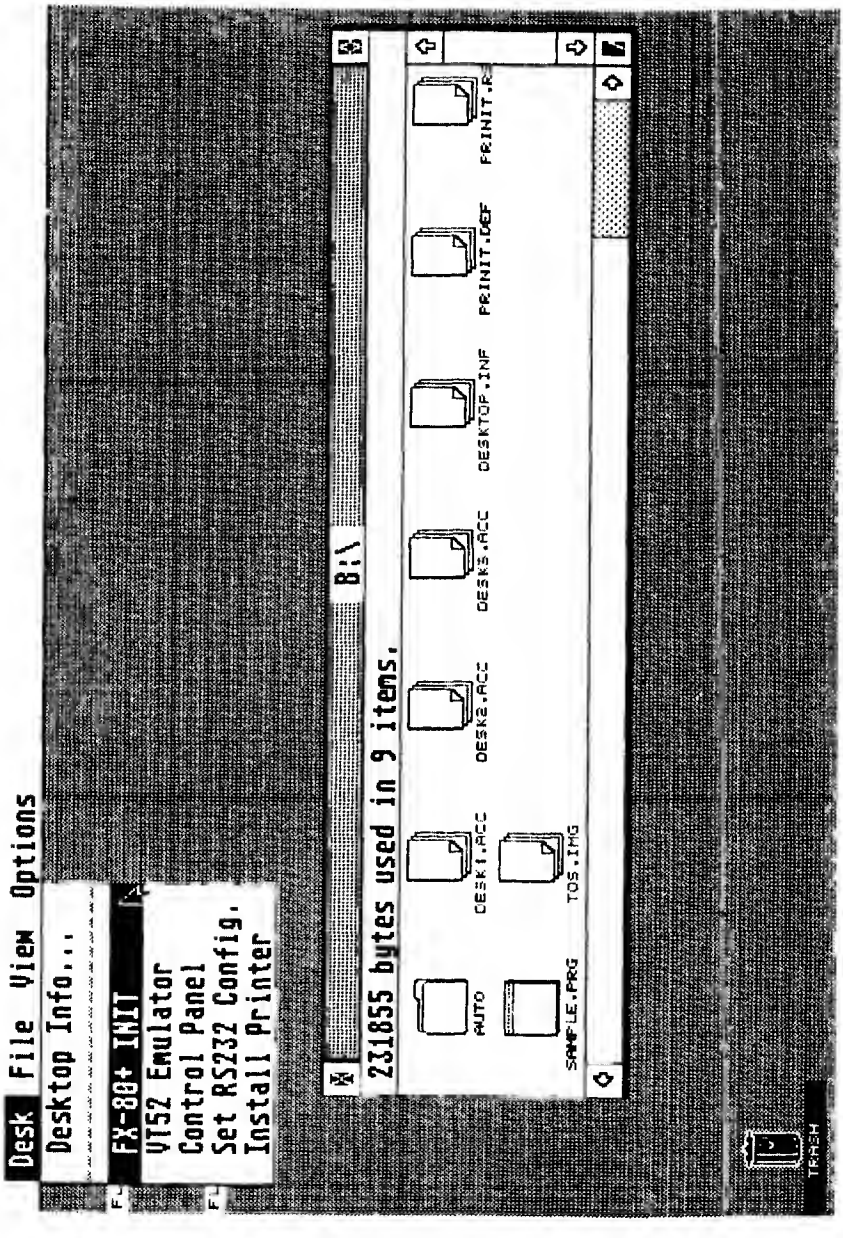
After `FXINIT` is installed, the printer initialization utility is removed from the *not ready list* and placed in the *ready list*. The dispatcher then "rotates" the tasks on the ready list. The first task from the ready list is processed for a predetermined amount of time, after which it is placed at the end of the ready list. Then the next task on the ready list is briefly processed, put at the end of the ready list, and so on. Using this method, the dispatcher evenly divides the CPU's time between the currently running program, a background program such as a print spooler, and the operating system. The dispatcher can manage up to six tasks.

The AES is a library containing subroutines to manipulate windows, read and handle the mouse, display system messages, interact with dialog boxes, and display drop-down menus.

The screen manager assumes control of the mouse when the cursor is positioned outside the work surface of the currently active window. The contents of the window are defined as the work surface. The title and information line are not part of the work surface. The screen manager becomes active when the user exits the bordered area of the topmost window—such as when he uses the drop-down menus of the menu bar. It supervises the actions of the user and lets him know if the current window needs to be redrawn.

The *shell* is also part of the AES. After the desktop is accessed, the shell is placed at the top of the ready list. It is responsible for calling an application. The desktop passes information to the shell indicating whether it is a TOS or GEM application, and gives the pathname to the application's subdirectory (folder). The desktop then terminates and the shell is responsible for loading and starting the application. When the application ends, the shell is called again to reactivate the desktop or start another application.

Figure 4-1


Desk File View Options
Desktop Info...
FX-80+ INIT
VT52 Emulator
Control Panel
Set RS232 Config.
Install Printer
B:\
231855 bytes used in 9 items.
AUTO
SAMPLE.PRG
DESK1.ACC
TOS.IMG
DESK2.ACC
DESK3.ACC
DESKTOP.INF
PRINIT.DEF
PRINIT.R
TRASH

Before writing a program for the ST, we must first distinguish between an application and an accessory.

An application is what we normally think of as a program on a conventional non-GEM computer. A wordprocessor or database management system is an example of an application. Applications are normally loaded into main memory and then started.

An accessory is a mini-application loaded into the accessory buffer during the boot procedure of TOS, and concurrently started. The role of an accessory is to wait until it is called into action by a main application.

### 4.1.3 The resource file

GEM uses a concept called a *resource file* to make applications flexible and easy to change. The resource file contains the structure of the pull-down menus, and the text of dialog boxes and alert messages. If the text of a menu or message needs to be altered, the program does not have to be changed. Instead, only the resource file need be changed.

The resource file for an application has the extension `.RSC`. It may be edited using the Resource Construction Set, which we'll discuss shortly.

Separating the text from the program makes it is easy to adapt an application to different countries. A developer need only edit the resource file to "move" an application, for example, from German to English. See Plate 8 for an example that uses TOS itself.

### 4.1.4 Working with TOS

Adapting an application to use the features of GEM is quite complicated. For this reason, many applications have been "ported" to the ST and do not use any of the GEM features such as pull-down menus or icons.

By sidestepping GEM, applications that were developed for other computers (in C, for example) can be easily adapted to the ST. By ignoring the special AES and VDI calls, the C programmer can be as comfortable with the ST as with a non-GEM computer.

The next example is a C program that does not use GEM. Instead, it is a pure TOS application.

## 4.2 Twenty-one

We'll explore TOS programming by writing a simple game. The name of the game's ***Twenty-one***. It's not the same game as the card game Blackjack, but a simple strategy game of the Nim variety.

Twenty-one is a two-player game. A counter is initially set to zero. Each player takes alternate turns, adding one or two to the counter. The winner is the player who reaches exactly twenty-one points on his turn. Naturally, one player is represented by the computer.

Here's one possible winning strategy in Twenty-one. Our goal, reaching a count of twenty-one, may be split into several subgoals. One strategy is to avoid reaching a count of 19 on our turn, or else our opponent will be able to reach 21. Instead, we want our opponent to reach 19—that is one of our subgoals. By the same token, another of our subgoals is to reach 16, since then our opponent cannot prevent us from reaching 19. If our opponent adds 1 to 16, then we add 1—thereby forcing him to reach 19 or 20.

By following a similar strategy we find these subgoals: 1, 4, 7, 10, 13, 16, and 19. Our strategy is to perform a corresponding move (+1 or +2) that will reach the next winning number.

Let's give a little thought to the structure of the program. It is a linear program, with parts for game initialization (`init`), game state output (`output`), player move (`computer`), evaluation and termination.

In the first section, the game instructions are displayed on the screen, the counter is set to zero, and the player is given a choice as to who will make the first move.

The player move section is made up of a simple function followed by a multiple choice (`getchr`, `switch case`). `Getchar` is a standard C library function to read a single digit. For this game, a single call is sufficient, since we'll only need to read a single digit. This value is then added to the counter using the increment operator ++. The C statement `state++` is similar to the BASIC statement. `state=state+1`.

Before the next player's turn, we check to see if the winning score has been reached within the main loop of the program— `while (state<goal)`.

This is done using:

```
if (state==goal) break;
```

With the routine `computer()`, the computer will always try to reach the next winning subgoal. If this isn't possible because the opponent has reached the same subgoal, then it doesn't matter if the move is +1 or +2 (+1 is the default).

If you're a beginning user of the C language, these explanations may interest you:

A C program is made up of a sequence of functions. When the program is started, the function `main()` is called. Every C program must contain a `main()` function.

You may use the `#include` and `#define` statements.

The `#include` statement instructs the compiler to insert the file `stdio.h` at this point in the source file. `stdio.h` contains the standard input/output functions commonly used by C programs. Providing these functions as a standard library ensures that this source program can run on other computers after compilation.

The `#define` statement lets you define symbolic constants. For example, you can define the symbol `YES` with the value of 1 (for true) or the symbol `NO` with a value of 0 (for false). For each subsequent occurence of a symbol within the source file, the compiler substitutes the corresponding value. This makes it easier to read and write programs, since the symbolic constants are more understandable than pure numeric or alpha values.

```
/* 21 - JW 16.08.1985  21 game*/

#include "stdio.h"

#define YES 1
#define NO 0

int objt,stand,sp,game;


main()
{
      hello();
start:init();
      if (sp == YES)
      {
               output();
               player();
      }

      while(stand<objt)
               {
               output();
               computer();
               if (stand == objt)
                     break;
               output();
               player();
               }
      end();
      printf("Another game ?\n");

      game=getchar();
      if (game == 'y')
         {
         goto start;
         }
}
```

```
hello()
{
   printf("******* T W E N T Y - O N E ******\n");
     printf("Object of the game is to get the \n");
    printf(" number 21 by adding by 1 or 2.   \n");
}


init()
{
      objt=21;
      stand=0;
      printf("\n\nWant to start?");

      game=getchar();
         if (game == 'y')
              sp = YES;
         else sp = NO;
      printf("\n");
}


output()
{
      printf("Game standing: %d\n",stand);
}


player()
{
   sp = YES;
      game=0;
      printf("\nWant to raise by 1 or 2 ?\n");

      game = (getchar() - '0');
      switch(game)
      {
         case 1 :
         {
            printf("\nOkay !\n");
            stand++;
            break;
         }
```

```
            case 2 :
            {
               printf("\nThat's fine, too!\n");
               stand++;
               stand++;
               break;
            }
            default :
            {
               printf("\nNot so many!!\n");
               player();
            }
         }
}


computer()
{
   sp = NO;
      switch(stand)
      {
         case 2:
         case 5:
         case 8:
         case 11:
         case 14:
         case 17:
         case 20:
         {
            plusone();
            break;
         }
         case 1:
         case 4:
         case 7:
         case 10:
         case 13:
         case 16:
         case 19:
         {
            printf("\nI raise by 2.\n");
            stand++;
            stand++;
```

```
            break;
         }
         default:
         {
            plusone();
         }
      }
}


plusone()
{
      printf("\nI raise by 1.\n");
      stand++;
}


end()
{
   if (sp == YES)
      printf("\n\nYou win!.\n\n");
   else
      printf("\n\nI was very lucky. \n\n");
}
```

Since a basic loader for this program would be quite large and really serve no useful purpose, we have not included one. For the BASIC programmers we have included the same program written in BASIC. You can compare the BASIC version with the C source code.

```
10    rem 21 program in basic
20    rem
30    YES = 1
40    NO = 0
50    rem main program
60    rem
70    gosub hello
80    start: gosub init
90    if sp = YES then gosub output: gosub player
100   while stand < obj
120   gosub output
130   gosub computer
140   if stand =obj then goto 150
145   gosub output: gosub player
150   wend
160   gosub ende
170   print"Another Game?";
180   game$ = input$(1)
190   if game$ = "y" then goto start
200   end
210   rem
220   rem
500   hello: fullw 2: clearw 2
510   print"****** T W E N T Y - O N E *****"
520   print"Object of the game is to get the"
530   print"number 21 by adding 1 or 2      "
540   return
550   rem
600   init: obj=21
610   stand = 0
620   print: print" Want to start" ;
630   game$ = input$(1)
640   if game$ = "y" then sp= YES else sp = NO
645   print
650   return
660   rem
700   output :print"Game standing:";stand
705   print
```

```
710   return
720   rem
800   player: sp = YES
810   game = 0
820   print "Want to raise by 1 or 2 ";
830   input game
850   if game = 1 then print"OK" : stand=stand+1 :
      return
860   if game = 2 then print"OK" : stand=stand+2 :
      return
870   print"Not so many": goto 810: rem call player
880   return
890   rem
900   computer: sp = NO
910   if stand = 1 goto plustwo
911   if stand = 4 goto plustwo
912   if stand = 7 goto plustwo
913   if stand = 10 goto plustwo
914   if stand = 13 goto plustwo
915   if stand = 16 goto plustwo
916   if stand = 19 goto plustwo
920   if stand = 2 goto plusone
921   if stand = 5 goto plusone
922   if stand = 8 goto plusone
923   if stand = 11 goto plusone
924   if stand = 14 goto plusone
925   if stand = 17 goto plusone
926   if stand = 20 goto plusone
930   goto plusone      : rem default
950   plusone: print"I raise by one"
955   stand= stand +1
958   return
960   plustwo: print "I raise by two"
965   stand = stand + 2
968   return
980   rem
1000  ende: if sp = YES then print "You win" else
      print"I was very lucky"
1010  return
```

## 4.3 The next step: A GEM application

Now that you've become acquainted with the C language and understand terms like include resource files and symbolic constants, we want to introduce you to a GEM application.

As previously illustrated, GEM, and especially the Virtual Device Interface, provides a very convenient user interface for a variety of graphic devices. The VDI can convert the output of any device—a raster screen, a dot-matrix printer, or a pen plotter—to the proper device-specific codes. The programmer need not concern himself with these codes.

To make use of any VDI services, the programmer must pass a request through a series of parameters. These parameters are five arrays:

- the control array (`contrl`)
- the input array (`intin`)
- the input array for point coordinates (`ptsin`)
- the output array (`intout`)
- the output array for point coordinates (`ptsout`)

All array elements are two bytes long, so corresponding variables are defined as integers in C. In the following example, the definitions appear at the beginning of the global variables.

The first step in a GEM program is to initialize these arrays. Next the workstation parameters are set, in order to open the workstation. The VDI function `OPEN WORKSTATION` loads the corresponding driver (not yet implemented on the ST), sets the output device for graphics operation, and prepares it for subsequent use.

At this time, certain workstation characteristics may be specified. For example, we may request that lines appear as black and dotted, rather than as solid lines. A variety of characteristics may be specified and passed on as parameters, shown as follows:

- Line type (dashed, shaded,...)
- Color of lines
- Marker type
- Color of the poly marker
- Type style
- Type color
- Fill pattern for drawing polygons
- Fill pattern
- Fill color

Most of these parameters have defaults with a value of 1.

One parameter is particularly important to us. Within the input array (`int_in`), the value of one element (10) determines the coordinate system. A value of zero selects normalized device coordinates (NDC) and a value of two selects raster coordinates (RC). Since we place a priority on speed, we select RC.

```
open_vwork()
{
int i;
    for (i = 1; i <10; i++) {
        int_in[i] = 1;
    }
    int_in[10] = 2;
    v_opnvwk(int_in, &handle, int_out);
}
```

To initialize the workstation we call `v_opnvwk(int_in, &handle, int_out)` Using the value passed by `handle`, we can address the work area created for our application.

If you look at `main()`, you will notice two other GEM calls.

`Appl_init` prepares a similar control array to use the AES. An identification code (`ap_id`) is returned to the application. The code is used to distinguished between multiple applications using the same resources (multi-tasking).

`Draw()` is our actual main program—in this example, where we draw the outline of a house.

Each GEM application must be properly terminated. Memory and other resources must be released so that other applications may make use of them.

Here are a few notes concerning the following listing:

All source statements preceding `draw()` may be placed in a separate file. In other programs these statements may be `#included`. To ensure the orderly termination of your application, the last lines of the program should be:

```
desktop();
```

At the end of the listing you'll find the `click()` function. This allows you to view the screen until the left mouse button is pressed.

```
/*********************************************************/
/*****              program: HOUSE1.C                ****/
/***** draw a house -- wait for the left mouse key    ****/
/*****              JW October 1985                  ****/
/*********************************************************/
                        /* include files                 */
#include "obdefs.h"     /* first time all are brought in */
#include "define.h"
#include "gemdefs.h"
#include "osbind.h"
#include "gembind.h"

                       /*global variables                */
int contrl[12];
int intin[128];
int ptsin[128];
int intout[128];
int ptsout[128];     /* enough space for all purposes   */

int handle,i;       /* virtual workstation handle       */
int phys_handle;    /* physical workstation handle      */
int pxyarray[12];   /* Array for x,y coordinates        */
int int_in[11];     /* input in GSX array               */
int int_out[57];    /* output from GSX array            */

int ap_id;          /* i.d. of application              */

int dummy;

main()
{
      ap_id=appl_init();
                /* initialize    GEMAES array-structures */
      handle=graf_handle(&dummy,&dummy,&dummy,&dummy);
                /* Desktop maintenance                   */
      open_vwork();
               /* Set up workspace                       */
      graf_mouse(256,&dummy);
               /* Mouse stuck                            */
      draw();
               /* produce artwork                       */
      v_gtext(handle,1,350,"Please click LEFT button..");
```

```
      click();   /* wait for left mouse key    ...          */
      desktop(); /* End-of-program                          */
}


open_vwork()
{
int i;
      for (i = 1; i <10; i++){
        int_in[i] = 1;
             /* init int_in array: linetype, color,    */
        }    /* fillstyles etc.                         */
      int_in[10] = 2;
             /* used RC - coordinates              */
      v_opnvwk(int_in, &handle, int_out);
             /* now it can go ....              */
}


desktop()
{
      v_clsvwk(handle);     /* workstation assigned        */
      appl_exit();          /* no more GEM calls           */
}


click()                   /* wait for mouse click (left)   */
{
      evnt_button(1,1,1,&dummy,&dummy,&dummy,&dummy);
}

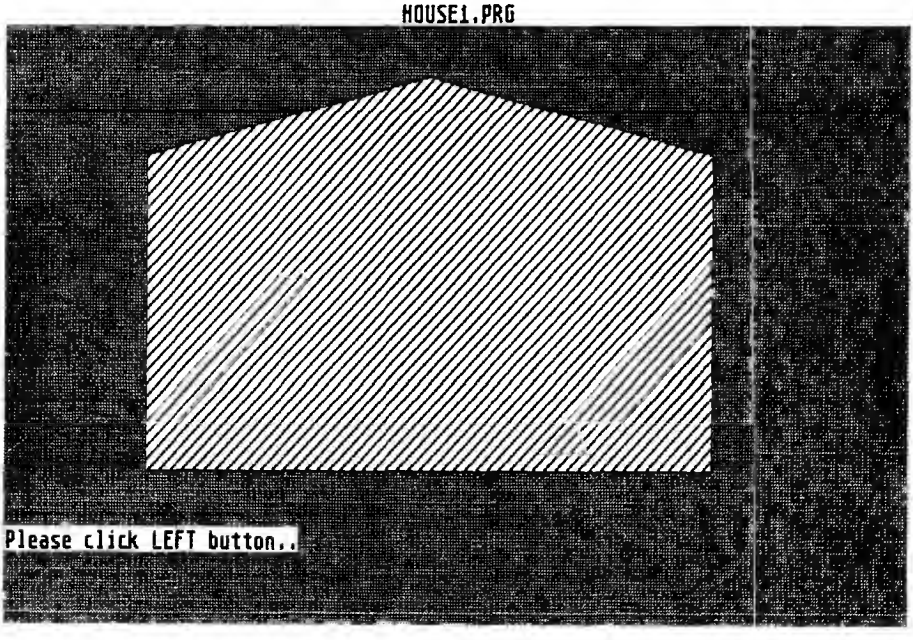

/*--here follows the program section --*/


draw()
      {
      int style;  /* Variable for fill pattern            */
      style = 3;  /* Choose fill pattern                  */
      pxyarray[0] = 100;    /* x-coordinate Point 1         */
      pxyarray[1] = 100;    /* y-coordinate point 1         */
      pxyarray[2] = 100;  /* Point 2                        */
```

```
        pxyarray[3] = 300;
        pxyarray[4] = 500;      /* Point 3                    */
        pxyarray[5] = 300;
        pxyarray[6] = 500;
        pxyarray[7] = 100;
        pxyarray[8] = 300;
        pxyarray[9] = 50;
        pxyarray[10] = 100;
        pxyarray[11] = 100;

        v_pline(handle, 6, pxyarray);
                    /* Polygon in workspace        :        */
                  /* 6 points with coordinates fr.pxyarray   */

        vsf_interior(handle, style);
                    /* set fill interior style: solid/hollow*/
        v_fillarea(handle, 6, pxyarray);
                    /* fill from polygon-generated          */
                   /* surface                               */
}
```



Hopefully we've succeeded in running an application on the desktop. The next step is the creation of a routine `open_window()`, which prepares a window as a work area for us.

Let's first give some thought to the size that our window should have. In GEM, the convention is to specify the upper left corner of an object as the reference point in pixel coordinates, and then specify the width and height, also in pixel units, relative to this point.

But few of us want to count out pixels or do conversions. The desktop is actually a window of maximum size. The VDI function `wind_get` returns these measurements to us.

Let's build upon the previous program `HOUSE1` with the call:

```
wind_get(0,WF_WORKXYWH,&xdesk,&ydesk,&wdesk,&hdesk);
```

Remember to enter the new variables in the declaration list:

```
int xdesk, ydesk, wdesk, hdesk;
```

The `wind_create()` function is used to create a window. It returns a window number (`wi_handle`) for identification. To create a window several parameters are specified. Each characteristic of a window is assigned one bit in an integer, as follows:

| | | |
|---|---|---|
| 0x0001 | NAME | title line with name |
| 0x0002 | CLOSER | close field |
| 0x0004 | FULLER | field for full size (top right) |
| 0x0008 | MOVER | window can be moved |
| 0x0010 | INFO | info line (such as 123456 bytes used) |
| 0x0020 | SIZER | enlargement field (lower left) |
| 0x0040 | UPARROW | arrow up |
| 0x0080 | DNARROW | arrow down |
| 0x0100 | VSLIDE | vertical slider |
| 0x0200 | LFARROW | arrow left |
| 0x0400 | RTARROW | arrow right |
| 0x0800 | HSLIDE | horizontal slider |

If your window is just a border around the work area with a title line, the first parameter when calling `wind_create` must have a value of 1. To close the window during termination, the first parameter is set to three (bit 00000011). Using bits can become complicated. One alternative is to use symbolic constants, which are defined within an `#include` file for this purpose.

The above symbols are standardized. In the case of C language, they are found in the file `GEMBIND.H`. The programmer can then use just the symbolic constants within his program:

```
#define WI_KIND (SIZER MOVER FULLER CLOSER NAME)
```

Once the window format is set, the title is set using the function `wind_set()`, and the window is finally opened.

We recommend that you place this sequence of instructions in a separate file to be `#included` in programs (thanks to the symbolic constants they can be easily used for any window):

```
open_window()
{
    wi_handle=wind_create(WI_KIND,xdesk,ydesk,wdesk,hdesk);
    wind_set(wi_handle, WF_NAME, " Tips & Tricks ",0,0);
    wind_open(wi_handle,xdesk,ydesk,wdesk,hdesk);
}
```

This creates a window on the screen. But many of the window features are inoperative. The event library, a part of the AES, tests for the special features. To determine if a mouse button is pressed, for example, we use the function in `click()` and test for the state `evnt_button`.

Messages between the user and GEM are communicated through an array called the message buffer (`msgbuff`). The message is placed in the first element `msgbuff(1)`. An indentifcation code for which this message applies is placed in `msgbuff(2)`. Information about required parameters are placed in the remaining entries.

If a menu entry is selected with the mouse—for example, the code 10 for `MN_SELECTED`—it is placed in `msgbuff(0)`. The pointer to the menu (e.g. DESK or FILE) is placed in `msgbuff(3)`, and the pointer of the selected object is placed in `msgbuff(4)`. This lets you determine the desired action.

The name MN_SELECTED is the designation for the symbolic constant defined in the #include file. The following symbolic constants are also used:

| | |
|---|---|
| MN_SELECTED | Menu entry selected |
| WM_REDRAW | The window must be redrawn |
| WM_TOPPED | This window should be activated |
| WM_CLOSED | The close field was activiated |
| WM_FULLED | The maximum size was set |
| WM_ARROWED | A arrow was clicked |
| WM_HSLID | The horizontal slider was used |
| WM_VSLID | The vertical slider was used |
| WM_MOVED | The window was moved |
| WM_NEWTOP | The window was activiated |
| AC_OPEN | Sent to the accessory selected in the desk menu |
| AC_CLOSE | Sent to the accessory to be closed |

To use all of the GEM window features, an application must handle all of the above conditions.

Using the evnt_multi() call, an application can be made to wait for a message, a mouse event, or a keypress, for example.

If you've written an application that seems to "hang up", but the pointer can still be moved with the mouse, then the ST probably hasn't crashed. Instead, you have not requested it to wait for an external event. Your application should probably be designed as a large loop that can't be exited until a specific termination condition is fulfilled. This can be a mouse click or the activation of the close field.

An example of this:

```
do (
   evnt_multi(....);
   window_control;

   your program follows here;

   ) while close field is not activated
```

The outline above is typical for an application. An accessory requires a somewhat different structure. For the time being, the following example demonstrates how to shrink, enlarge and move the window.

```
/*************************************************************/
/********          Program: HOUSE3.C                  *******/
/********       complete window control               *******/
/********            JW October 1985                  *******/
/*************************************************************/

                    /* include files                          */
#include "obdefs.h" /* first time around, so it gets all     */
#include "define.h" /* data necessary ...                     */
#include "gemdefs.h"
#include "osbind.h"
#include "gembind.h"

                    /* Definition for later reference  */

#define WI_KIND    (SIZER|MOVER|FULLER|CLOSER|NAME)
                    /* work window: Title, border.....    */
#define MIN_WIDTH  (2*gl_wbox)
#define MIN_HEIGHT (2*gl_hbox)

extern int gl_apid;
                   /*global variables                       */
int contrl[12];
int intin[128];
int ptsin[128];
int intout[128];
int ptsout[128];  /* enough space for all cases          */

int handle,i;     /* virtual workstation handle          */
int phys_handle;  /* physical workstation handle         */
int pxyarray[12]; /* Array for  x,y coordinates          */
int int_in[11];   /* Input in GSX array                  */
int int_out[57];  /* Output from GSX array               */

int wi_handle;   /* Handling the applicable window         */
int top_window;  /* Open window                            */
int xdesk, ydesk, wdesk, hdesk;
                  /* Parameters for window size            */
int xold, yold, hold, wold;
int xwork, ywork, hwork, wwork;

int mx, my;    /* x and y coordinates of mouse          */
int butdown;
```

```
int ap_id;        /* Application id                          */
int menu_id;      /* Working window id                       */
int fulled;
int hidden;

int msgbuff[8];   /* event message buffer                    */
int keycode;      /* contains char. codes from evnt_keybrd */

int gl_wchar, gl_hchar; /* Char. height                      */
int gl_wbox, gl_hbox;

int dummy;



/*********************************************************/
/* Necessary initialization                              */
/*********************************************************/

open_vwork()
{
int i;
      for (i = 0; i <10; i++){
        int_in[i] = 1;
                  /* init int_in array: linetype, color,   */
        }         /* fillstyles etc.                       */
      int_in[10] = 2;     /* RC - coordinates used         */
      handle=phys_handle;
      v_opnvwk(int_in, &handle, int_out); /* off we go... */
}

/*********************************************************/
/* open window                                           */
/*********************************************************/

open_window()
{
   wi_handle=wind_create(WI_KIND,xdesk,ydesk,wdesk,hdesk);
   wind_set(wi_handle, WF_NAME," The T&T House",0,0);

graf_growbox(xdesk+wdesk/2,ydesk+hdesk/2,gl_wbox,gl_hbox,xde
sk,ydesk,wdesk,hdesk);
```

```
   wind_open(wi_handle,xdesk,ydesk,wdesk,hdesk);

wind_get(wi_handle,WF_WORKXYWH,&xwork,&ywork,&wwork,&hwork);
}


/*********************************************************/
/* Show mouse / conceal mouse                            */
/*********************************************************/

show_mouse()
{
      graf_mouse(257,&dummy);
}

hide_mouse()
{
      graf_mouse(256,&dummy);
}


/*********************************************************/
/* clipping parameter set                                */
/*********************************************************/

set_clip(x,y,w,h)
int x,y,w,h;
{
int clip[4];
   clip[0]=x;
   clip[1]=y;
   clip[2]=x+w;
   clip[3]=y+h;
   vs_clip(handle,1,clip);
}
```

```
/*************************************************************/
/* Re-appear after windo manipulation                        */
/*************************************************************/

do_redraw(xc,yc,wc,hc)
int xc,yc,wc,hc;
{
GRECT t1,t2;

   hide_mouse();
   wind_update(TRUE);
   t2.g_x=xc;
   t2.g_y=yc;
   t2.g_w=wc;
   t2.g_h=hc;

wind_get(wi_handle,WF_FIRSTXYWH,&t1.g_x,&t1.g_y,&t1.g_w,&t1.
g_h);
   while (t1.g_w && t1.g_h)
      {
      if (rc_intersect(&t2,&t1))
         {
         set_clip(t1.g_x, t1.g_y, t1.g_w, t1.g_h);
         draw_house();
         }

wind_get(wi_handle,WF_NEXTXYWH,&t1.g_x,&t1.g_y,&t1.g_w,&t1.g
_h);
      }
     wind_update(FALSE);
     show_mouse();
}


/*************************************************************/
/*  Read from events: Window, Mouse, Keyboard                */
/*************************************************************/

multi()
{
int event;

      do{
```

```
      event = evnt_multi(MU_MESAG | MU_BUTTON | MU_KEYBD,
         1,1,butdown,
         0,0,0,0,0,
         0,0,0,0,0,
         msgbuff,0,0,&mx,&my,&dummy,&dummy,&keycode,&dummy);


/*********************************************************/
/* WINDOW(): Window management: shifting, sizes. etc.    */
/*********************************************************/

   wind_update(TRUE);

   if (event & MU_MESAG)
     switch (msgbuff[0]) {

     case WM_REDRAW:

do_redraw(msgbuff[4],msgbuff[5],msgbuff[6],msgbuff[7]);
       break;

     case WM_NEWTOP:
     case WM_TOPPED:
       wind_set(wi_handle,WF_TOP,0,0,0,0);
       break;

     case WM_SIZED:
     case WM_MOVED:
       if(msgbuff[6]<MIN_WIDTH)msgbuff[6]=MIN_WIDTH;
       if(msgbuff[7]<MIN_HEIGHT)msgbuff[7]=MIN_HEIGHT;

wind_set(wi_handle,WF_CURRXYWH,msgbuff[4],msgbuff[5],msgbuff
[6],msgbuff[7]);

wind_get(wi_handle,WF_WORKXYWH,&xwork,&ywork,&wwork,&hwork);
       break;

     case WM_FULLED:
       if(fulled){
      wind_calc(WC_WORK,WI_KIND,xold,yold,wold,hold,
            &xwork,&ywork,&wwork,&hwork);
      wind_set(wi_handle,WF_CURRXYWH,xold,yold,wold,hold);}
       else{
```

```
      wind_calc(WC_BORDER,WI_KIND,xwork,ywork,wwork,hwork,
            &xold,&yold,&wold,&hold);
      wind_calc(WC_WORK,WI_KIND,xdesk,ydesk,wdesk,hdesk,
            &xwork,&ywork,&wwork,&hwork);

wind_set(wi_handle,WF_CURRXYWH,xdesk,ydesk,wdesk,hdesk);
       }
       fulled ^= TRUE;
       break;

     } /* switch (msgbuff[0]) */

   if ((event & MU_BUTTON)&&(wi_handle == top_window))
     if(butdown) butdown = FALSE;
     else butdown = TRUE;

     if(event & MU_KEYBD){
        do_redraw(xwork,ywork,wwork,hwork);
     }

   wind_update(FALSE);

        }while(!((event & MU_MESAG) && (msgbuff[0] ==
WM_CLOSED)));
                    /* Enclosure was chosen              */
      wind_close(wi_handle);

graf_shrinkbox(xwork+wwork/2,ywork+hwork/2,gl_wbox,gl_hbox,x
work,ywork,wwork,hwork);
      wind_delete(wi_handle);       /* Free up memory      */
      v_clsvwk(handle);             /* assign workstation  */
      appl_exit();                  /* and goto Desktop    */

}


main()
{
      appl_init(); /* initialize GEM AES array-structures */

      phys_handle=graf_handle(&gl_wchar, &gl_hchar,
                              &gl_wbox, &gl_hbox);
```

```
                                    /* Handling the  Desktop  */
    wind_get(0,WF_WORKXYWH, &xdesk, &ydesk, &wdesk, &hdesk);

      open_vwork();              /* Open workspace              */
      open_window();             /* Open application window     */
      graf_mouse(ARROW,&dummy);     /* Mouse form               */


      hidden=FALSE;
      fulled=FALSE;
      butdown=TRUE;
      multi();                /* What does the user do?  */

}



/*-- Program follows from here to end of source--*/


draw_house()
      {
      int style;                  /* Fill-pattern variable  */
      int temp[4];

      vsf_interior(handle,2);        /* blank screen fill    */
      vsf_style(handle,8);           /* set fill  solid      */
      vsf_color(handle,0);           /* set color to white   */
      temp[0]=xwork;                 /* set coordinates      */
      temp[1]=ywork;
      temp[2]=xwork+wwork-1;
      temp[3]=ywork+hwork-1;
      v_bar(handle,temp);             /* draw large bar      */

      style = 3;                    /* Choose fill-pattern  */
      pxyarray[0] = 100;            /* x-coordinate point 1 */
      pxyarray[1] = 100;            /* y-coordinate point 1 */
      pxyarray[2] = 100;            /* Point 2              */
      pxyarray[3] = 300;
      pxyarray[4] = 500;            /* Point 3              */
      pxyarray[5] = 300;
      pxyarray[6] = 500;
```

```
      pxyarray[7] = 100;
      pxyarray[8] = 300;
      pxyarray[9] = 50;
      pxyarray[10] = 100;
      pxyarray[11] = 100;

      vsf_color(handle,1);          /* set color to  black */

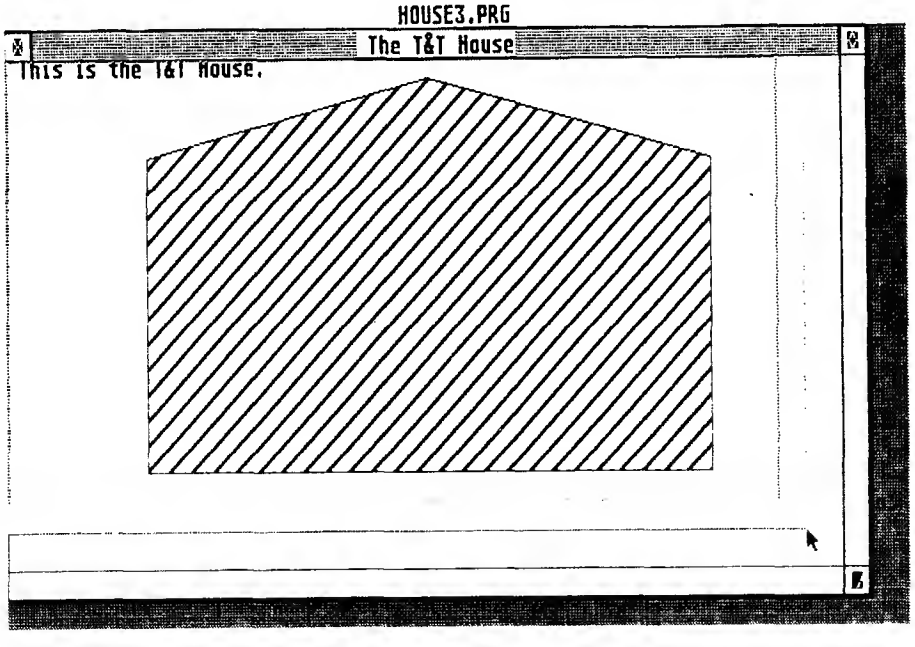
      v_pline(handle, 6, pxyarray);/*Polygon in workspace */

                  /* 6 points w/ coordinates in   pxyarray*/

      vsf_interior(handle, style);
                  /* set fill interior style: solid/hollow*/

      v_fillarea(handle, 6, pxyarray);
                     /* fill Polygon-enclosed surface     */

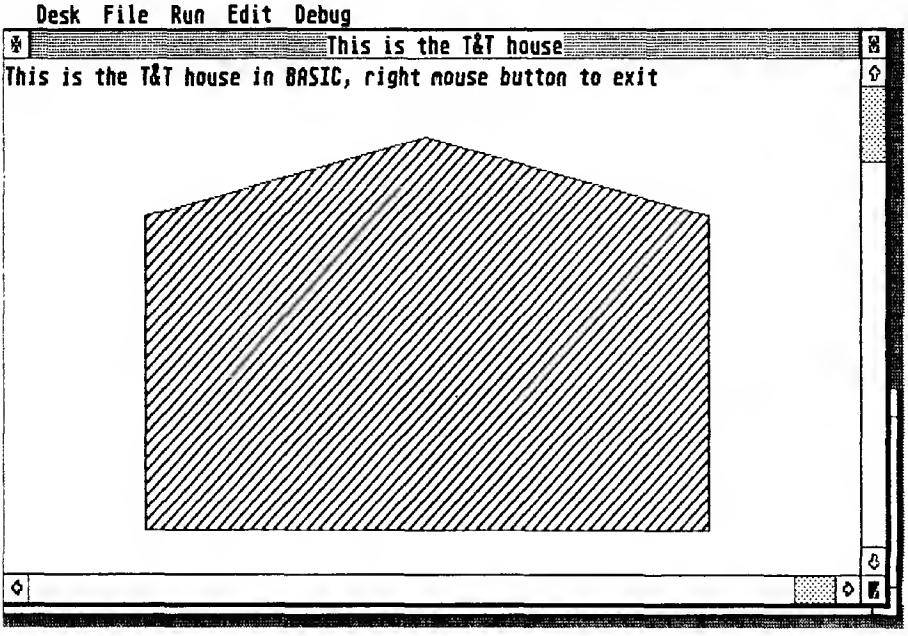
          v_gtext(handle,10,gl_hchar*3,"This  is  the  T&T
House.");
}
```



Since a basic loader for this program would serve no useful purpose, we have not included one. For the BASIC programmers we have included the HOUSE3 program written in BASIC. You can compare the BASIC version with the C source code. You will notice that the BASIC version is much shorter since BASIC takes care of the necessay GEM initializations. Parts of the program should look familiar. They are from Chapter 1 and merged into this program.

```
10    rem house3 in basic
20    gosub gem.arrays
30    x1=0:a$="This is the T&T house"
40    poke int.in  ,3
50    poke int.in+2,2
60    x1=varptr(a$)
70    poke int.in+4,x1 / 2^16
80    poke int.in+6,x1 and &hffff
90    poke int.in+8,0
100   poke int.in+10,0
110   gemsys 105
120   '
130   rem main
140   '
150   fullw 2:clearw 2
160   gosub house : rem draw
170   '
180   mouse:rem read right mouse button
190   poke contrl,124
200   poke contrl+2,0
210   poke contrl+4,0
220   vdisys
230   button = peek(intout)
240   if button <>2 then goto mouse
250   end
260   house: style = 2 : index = 3 : colour = 1
270   linef 100,100,100,300
280   linef 100,300,500,300
290   linef 500,300,500,100
300   linef 500,100,300,50
310   linef 300,50 ,100,100
320   color colour,colour,colour,style,index
330   fill 150,150
```

```
340    gotoxy 0,0: print"This is the T&T house,
       right mouse button to exit";
350    return
360    gem.arrays:
370    int.in    = peek(gb+8) *2^16 + peek(gb+10)
380    return
```



## 4.3.1 PRINIT - An example application

Now that we've used some pratical GEM techniques, let's create our first real application. Then we'll show you how to create an accessory, for use within DESK on the menu bar.

The application is a short program to set a printer to different type fonts, margins, etc. This is a good candidate for a desk accessory. The alternative way to set up the printer is to use BASIC to send sequences of CHR$ statements to the printer.

To make our application easy to use we'll use a "dialog box" for the input. What is the quickest and easiest method for creating this type of dialog box?

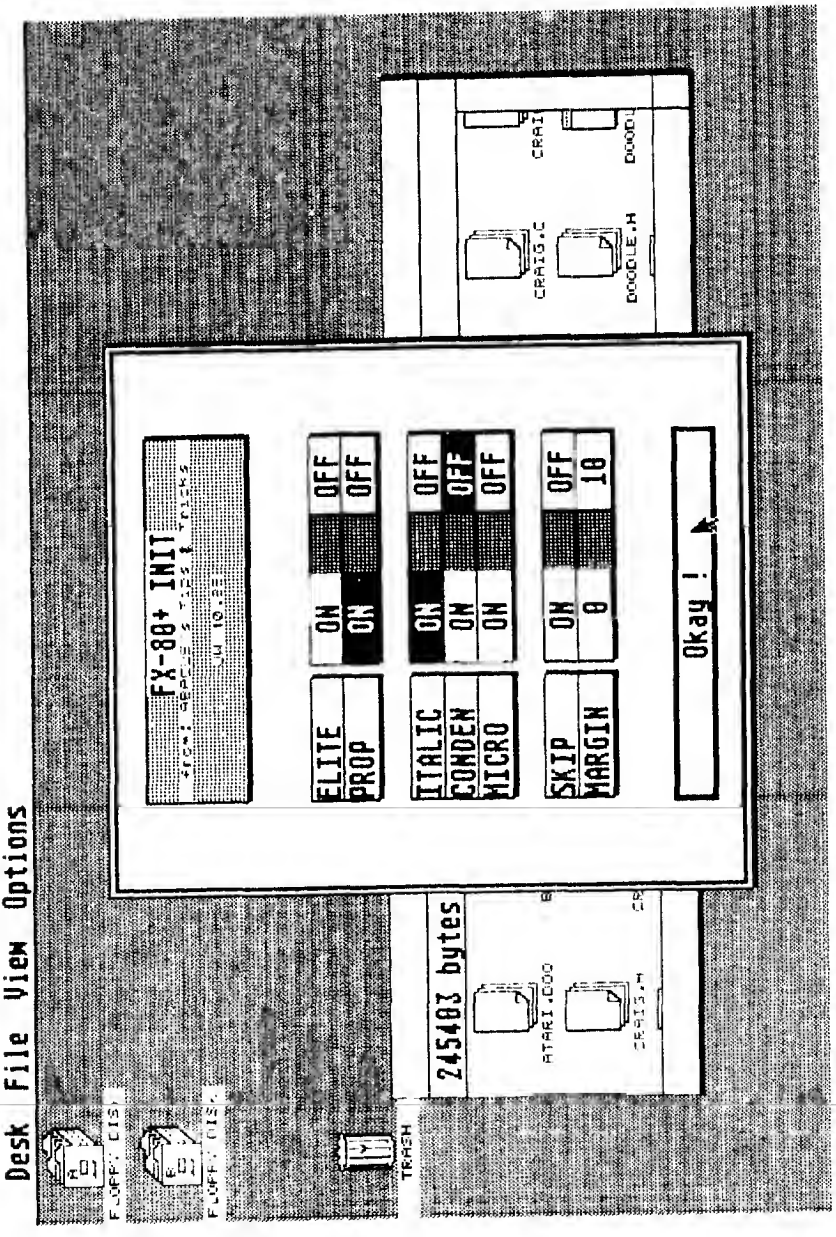
The Resource Construction Set (RCS), which is part of the Atari Development Package lets you easily create dialog boxes. With this utility program, all of the required menu structures can be created and later edited—in no time at all. The RCS creates .RSC files, which contain all of the specifications concering the dialog box and the required inputs. These specifications are loaded into memory by the `rsrc_load(filename)` function when the program is later executed.

The biggest advantage of using resource files is that they can be easily changed. This allows for quick translations of your application into a foreign language. To change the following application for use in Germany only the resource file would have to be edited and not the complete program.

Our application program sets several parameters for the Star SG-10 printer. To show the flexibility of resource files, we will later change the application to a desk accessory to work with an Epson FX-80 printer.

In the next section we'll show you all of the necessary steps for constructing the PRINIT.RSC file.

Figure 4-2


Desk File View Options
FX-80+ INIT
ELITE
PROP
ON
OFF
ITALIC
CONDEN
MICRO
SKIP
MARGIN
10
Okay !
245403 bytes
TRASH
CRAIG.C
DOODLE.H

## 4.4 Building a RSC file

Start the Resource Construction Set from the ST Development System utilities disk. Two windows will appear on the screen. In the top one, the RESOURCE PARTBOX, all of the components available are pictured.

You must now decide if you want to build a MENU or a DIALOG tree, within which the user can select between several alternatives.

These two types are the most-used, but there is also the ALERT tree, which is very similar in structure to the DIALOG tree and is used to send messages to the user. In addition, the RCS recognizes the tree FREE, which places almost no restrictions on the programmer. The only condition that applies to this tree is that no object may extend outside of another, while the others must observe certain formatting rules.

The tree symbolized by a question mark is only a place holder until the programmer finally knows what it does and correspondingly, what to call it. If a tree of type unknown (?) is found within the resource file, you can rest assured that the program will crash.

To start building our tree, drag the icon for a DIALOG tree to the lower window. The RCS displays its own dialog box (Figure 4-3) and asks us to name this tree. Enter SGMENU (in uppercase) and press <RETURN> or click the OK box. The dialog box will disappear.

Next move the mouse pointer to the lower window. Then select the dialog box SGMENU and OPEN it from the FILE menu or by doubling clicking. A new window is opened on top of the lower window.

Select the component BOXTEXT from the upper window and drag a copy of it to the lower window, SGMENU. We will use BOXTEXT, a simple box containing text, in order to name the various print options (ELITE, ITALIC, ...); for our application we will need seven boxes of this type. We can use the copy operation to make this task easier. To do this select BOXTEXT in the lower window and drag it to the desired screen position, but this time holding down the <SHIFT> key. Repeat this procedure until you have the appropriate number of BOXTEXT boxes. See Figure 4-4 for the placement of the boxes. Now open each BOXTEXT and enter the following in the TEXT field: ELITE, PROPO, ITALICS, CONDEN, NLQ, SKIP, MARGIN.

Figure 4-3

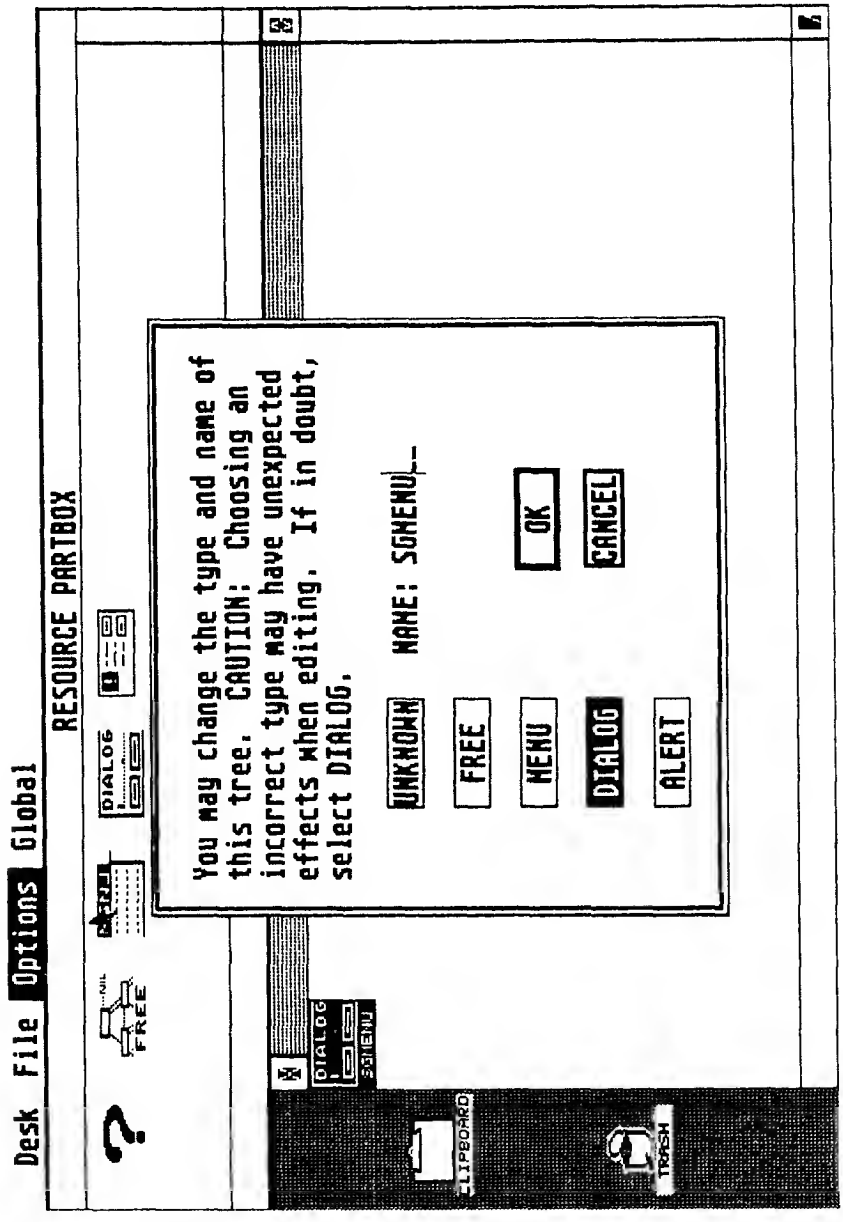
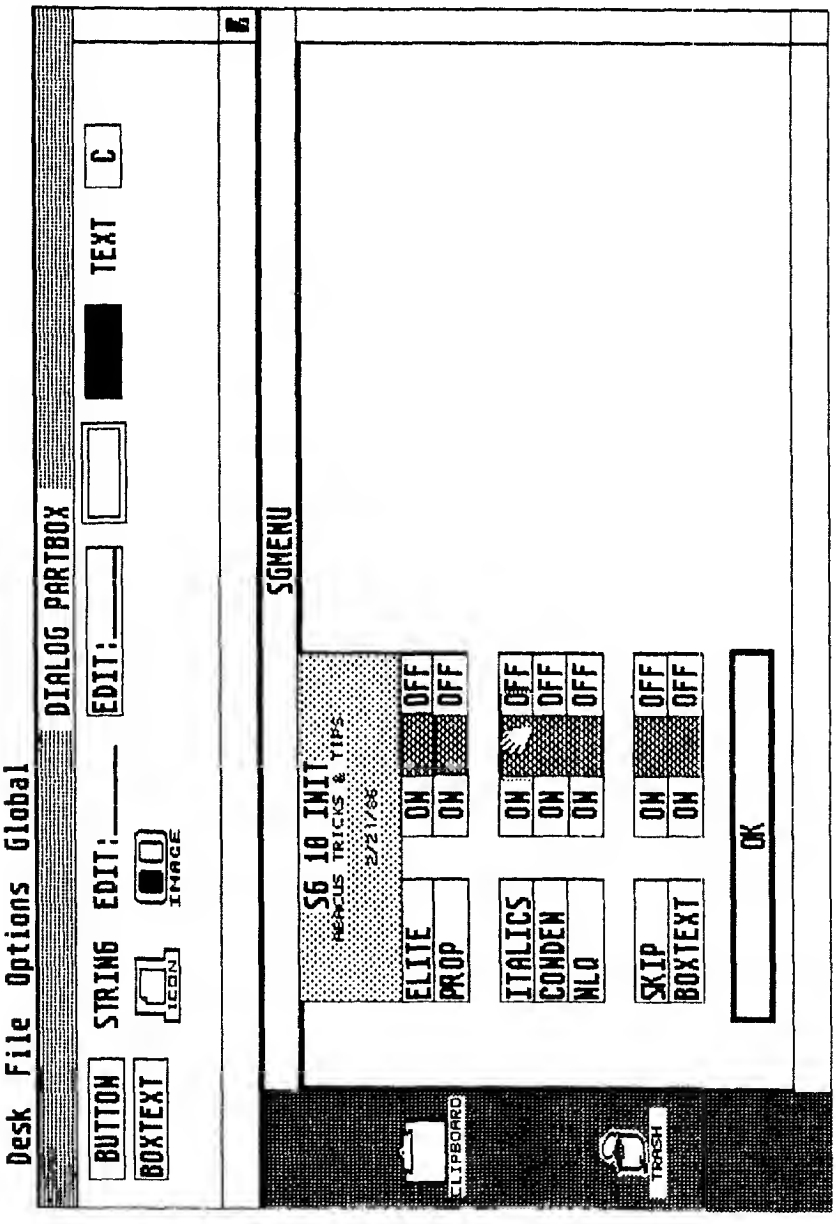

Desk File Options Global
RESOURCE PARTBOX
FREE
DIALOG
DIALOG
SGMENU
CLIPBOARD
TRASH
You may change the type and name of this tree. CAUTION: Choosing an incorrect type may have unexpected effects when editing. If in doubt, select DIALOG.
UNKNOWN
NAME: SGMENU
FREE
MENU
OK
DIALOG
CANCEL
ALERT

Figure 4-4


Desk File Options Global
DIALOG PARTBOX
BUTTON
STRING EDIT:
EDIT:
TEXT
C
BOXTEXT
ICON
IMAGE
SOMENU
S6 10 INIT
HEXCUS TRICKS & TIPS
2/21/88
ELITE
PROP
ON
OFF
ITALICS
CONDEN
WLO
SKIP
BOXTEXT
OK
CLIPBOARD
TRASH

Each of the ON/OFF switches in the SGMENU (see Figure 4-2) is seperated by a shaded box (the third element from the right within the PARTBOX - see Figure 4-4). Drag it into the lower window and resize it to the desired size by clicking on the edge and moving the outline. Place this box to the right of the first BOXTEXT box.

Double click this box or select Open from the File menu. The RSC presents you with another dialog box, by which you set the parameters for the appearance of this box (see Figure 4-5.) Select a shaded background and the number 1 from the Background choices. Now press the OK box.

So that we may select each ON or OFF they will be represented by a BUTTON. Select a BUTTON in the partbox and position it to one side of the shaded box just created. Then move a copy of this button to the other side of the shaded box.

Open the left BUTTON with a double click and enter ON as the text. You should also select SELECTABLE and RADIO BUTN. Then press the OK box. Open the BUTTON on the right side and enter the text OFF. Select SELCTABLE and RADIO BUTN for this box (see Figure 4-6.) Resize these boxes for the most pleasing asppearence. Then place these boxes next to the first BOXTEXT.

After this is done, copy the three boxes for each BOXTEXT present. Edit the boxes next to MARGIN so that ON is 0 and OFF is 10.

The last important control element for you to create is another BUTTON with the text "OK" and define it as SELECTABLE, DEFAULT, and EXIT. Drag the BUTTON below the BOXTEXTs and OPEN it to make your choices. Resize this box to create a symetrical appearence.

We're done, except for the title field, which consists of a large BOX outfitted with three elements of type TEXT. Select a box from the parts box and drag it into the lower window. Resize this box to fit, then open the box and add shading. Next select TEXT from the parts box and move it into the box. Copy text so you have three TEXTs in the box. Open the top TEXT and input SG10 INIT as text, select Lg Font. Select the second text, OPEN it and enter ABACUS Tricks and Tips. This time choose Sm Font. The third TEXT is opened and todays date is input as Sm Font.

Now OPEN the work window fully by clicking the box in the upper right hand corner. Then resize the large white box and repostion for appearence.

Now we must create the references so that our program later knows exactly which box has been selected. The function NAME within the OPTION menu of the title line serves this purpose.

You need to assign names only to objects which will be assigned a program function later. In our case we used the descriptions; ELITEIN, ELITEOUT, PROPIN, PROPOUT, ITALIN, ITALOUT, CONDENIN, CONDENOT, NLQIN, NLQOOT, SKIPIN, SKIPOUT, MARGIN0, MARGIN10, and EXIT for the OK field. Select each item (ON, OFF, 0, 10) and from the OPTIONS menu Name them accordingly.

Then click the close box on the window so that the DIALOG icon appears in the lower window. Next enter the File menu and tell the RCS to save the whole thing under the name "PRINIT.RSC" with the Save As option.

This will create the desired files, PRINIT.RSC, PRINIT.DEF and PRINIT.H. Then click the close field of the lower window so the RCS view window is empty again. Quit the RCS.

On your diskette you will find the following files:

PRINIT.RSC - the resource file for the following program
PRINIT.H - an include file with all of the symbolic constants
PRINIT.DEF - an RCS file

Now that we have instructed you in the use of the RCS, here is a brief look at all of the components in the file as well as the optional parameters required for C programming.

The first thing listed is the object type. Most of the objects which you use for constructing your resources are of type BOX. They may be one of the following:

| | |
|---|---|
| G_IBOX, G_BOX | empty boxes |
| G_BOXCHAR | contains a single character |

If there are strings in the RSC file they are one of the following:

| | |
|---|---|
| G_STRING | a text string |
| G_BUTTON | a string enclosed by a box |
| G_TITLE | a string within a menu bar |

Figure 4-5

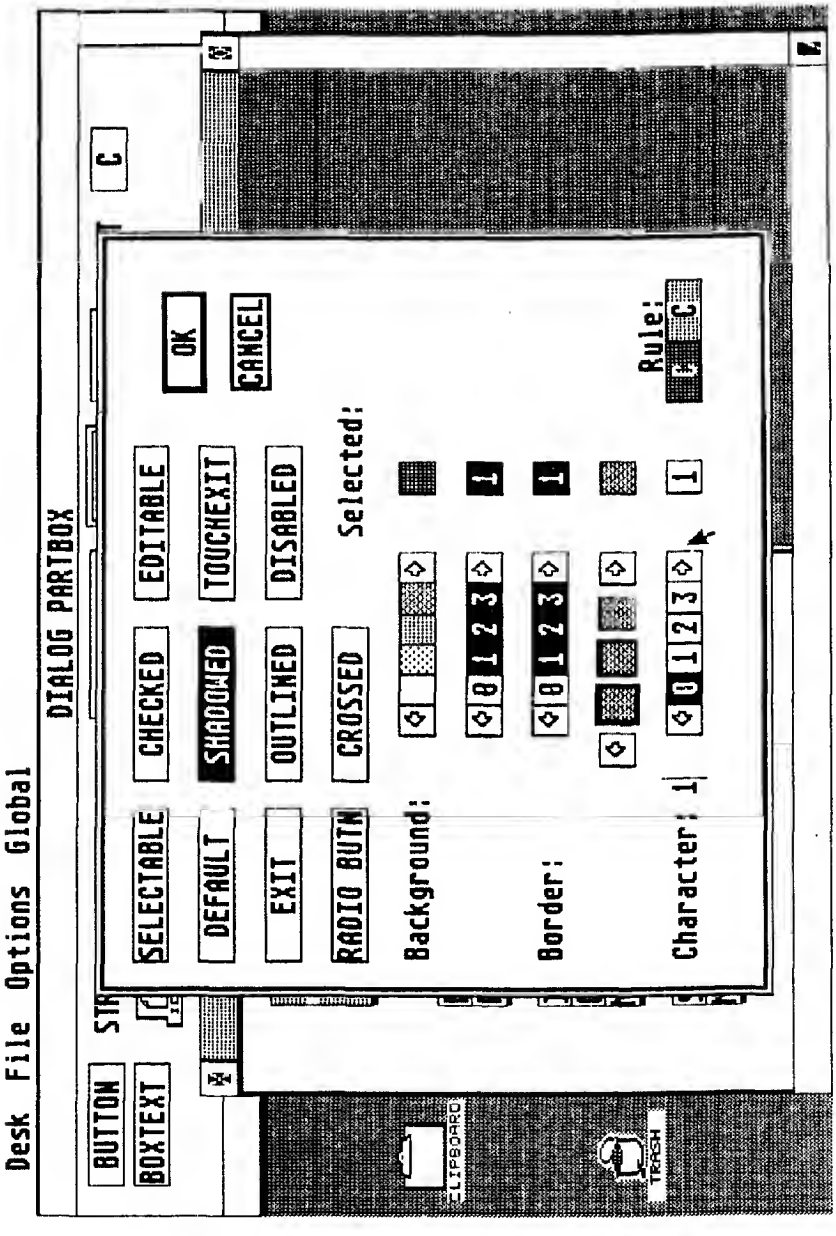
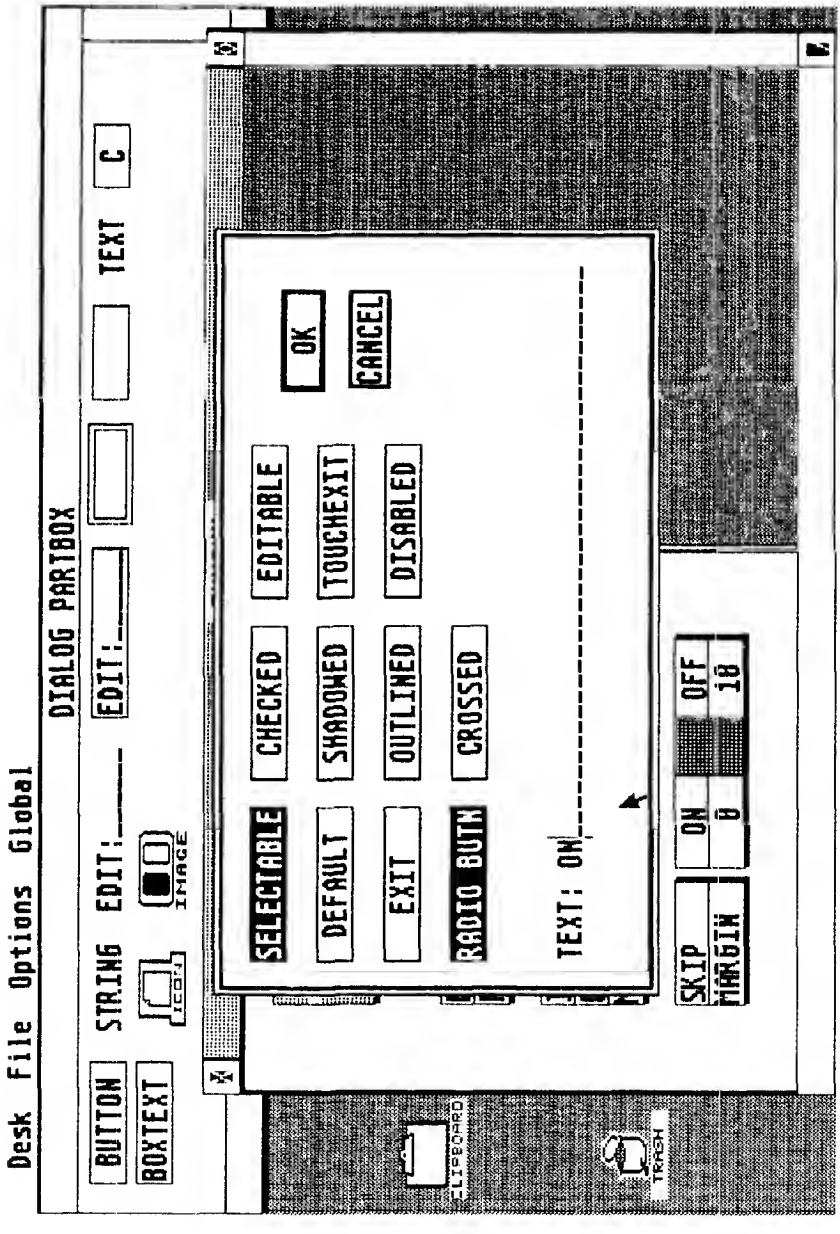

Desk File Options Global
DIALOG PARTBOX
BUTTON
BOXTEXT
SELECTABLE
DEFAULT
EXIT
RADIO BUTN
CHECKED
SHADOWED
OUTLINED
CROSSED
EDITABLE
TOUCHEXIT
DISABLED
Selected:
OK
CANCEL
Background:
Border:
Character:
Rule:
CLIPBOARD
TRASH

Figure 4-6


Desk File Options Global
DIALOG PARTBOX
BUTTON
BOXTEXT
STRING
EDIT:
EDIT:
TEXT
C
ICON
IMAGE
SELECTABLE
DEFAULT
EXIT
RADIO BUTN
CHECKED
SHADOWED
OUTLINED
CROSSED
EDITABLE
TOUCHEXIT
DISABLED
OK
CANCEL
TEXT: ON
SKIP
ON
OFF
MARGIN
0
10
CLIPBOARD
TRASH

In addition, the RCS recognizes formatted text types, which are used for messages to be edited (such as in the file selection menu):

| | |
|---|---|
| G_TEXT | is a formatted string |
| G_BOXTEXT | formatted string within a box |
| G_FTEXT | editable text |
| G_FBOXTEXT | editable text within a box |

After putting the desired objects in the tree, you must set the object status and some flags:

| | |
|---|---|
| Selected | draws an object in reverse |
| Crossed | crosses a box |
| Checked | displays a checkmark to the left of an object |
| Disabled | represents the object at half intensity |
| Outlined | the object contains another border (not together with Shadowed) |
| Shadowed | draws a shadow around the box (not with Outlined) |
| Selectable | the object can be activated during the course of the program |
| Default | pressing the <RETURN> key selects this object; it is display with a dark border |
| Exit | ends a dialog |
| Editable | the object contains editable text |
| Rbutton | the object belongs to a group of which only one can be selected |
| Hidetree | the object is not drawn with an Objc_Draw call |
| Touchexit | as soon as the mouse pointer is over such an object, the dialog is ended (without a clock operation) |

On the following pages is a listing of the printer initialization program. Note that the .H file was merged into the main file by using a text editor.

If you have create a RSC file with the Resource Construction Set, note the values defined for each symbol so that these may be used in your C programs. For example, the value for the symbol EXIT is 5. The values in your .H file will differ from the ones in the following PRINT.H listing. Consult the .H file listing that you create and use these values in place of those below.

```
/*********************************/
/* This file was created by the  */
/* authors using the RCS. The    */
/* values in your .H file will   */
/* differ from these. Substitute */
/* the values from your listing  */
/* in the printer initialization */
/* listing.                      */
/* PRINIT.H file  created by RCS */
/*********************************/

#define SGMENU 0        /* TREE */
#define EXIT 5          /* OBJECT in TREE #0 */
#define ELITEIN 7       /* OBJECT in TREE #0 */
#define PROPIN 10       /* OBJECT in TREE #0 */
#define PROPOUT 11      /* OBJECT in TREE #0 */
#define ITALIN 13       /* OBJECT in TREE #0 */
#define ITALOUT 14      /* OBJECT in TREE #0 */
#define CONENIN 16      /* OBJECT in TREE #0 */
#define CONDENOT 17     /* OBJECT in TREE #0 */
#define NLQIN 19        /* OBJECT in TREE #0 */
#define NLQOUT 20       /* OBJECT in TREE #0 */
#define SKIPIN 22       /* OBJECT in TREE #0 */
#define SKIPOUT 23      /* OBJECT in TREE #0 */
#define MARGIN0 26      /* OBJECT in TREE #0 */
#define MARGIN10 25     /* OBJECT in TREE #0 */
#define ELITEOUT 8      /* OBJECT in TREE #0 */
```

```
/*********************************************************************/
/*                    Printer initialization program                 */
/*                    for STAR SG-10  printer                        */
/*********************************************************************/

/*********************************************************************/
/* Use #include "PRINIT.H" or merge file into text using  your editor */
/* Your values from the RSC will be different from those listed below */
/*********************************************************************/

#define SGMENU 0                    /* TREE                          */
#define EXIT 5                      /* OBJECT in TREE #0             */
#define ELITEIN 7                   /* OBJECT in TREE #0             */
#define ELITEOUT 8                  /* OBJECT in TREE #0             */
#define PROPIN 10                   /* OBJECT in TREE #0             */
#define PROPOUT 11                  /* OBJECT in TREE #0             */
#define ITALIN 13                   /* OBJECT in TREE #0             */
#define ITALOUT 14                  /* OBJECT in TREE #0             */
#define CONDENIN 16                 /* OBJECT in TREE #0             */
#define CONDENOT 17                 /* OBJECT in TREE #0             */
#define NLQIN 19                    /* OBJECT in TREE #0             */
#define NLQOUT 20                   /* OBJECT in TREE #0             */
#define SKIPIN 22                   /* OBJECT in TREE #0             */
#define SKIPOUT 23                  /* OBJECT in TREE #0             */
#define MARGIN0 26                  /* OBJECT in TREE #0             */
#define MARGIN10 25                 /* OBJECT in TREE #0             */.

long menu_tree;                     /* Address OF RSC-Objects        */

/*********************************************************************/
/*                                  Definition BUTTON in Menus       */
/*********************************************************************/
#define SELECTED 0x0001
#define NORMAL 0x0000
#define WI_KIND 0x0001              /* Window has Name line          */
/*********************************************************************/
/*                                  Printer codes for                */
/*                                       : STAR SG-10                */
/*********************************************************************/
#define RET 13                      /* Return                        */
#define ESC 27                      /* Escape                        */
#define BELL 7
#define SMALL 15                    /* Small print                   */
#define SMALLOFF 18
#define ELITE 77                    /* Elite                         */
#define ELITEOFF 80
#define PROPORTIONAL 112            /* Proportional                  */
```

```
#define PSET 1                          /*  on                              */
#define PRESET 0                        /*  off                             */
#define ITALIC 52                       /* Italic                           */
#define ITALICOFF 53
#define NLQ1 66                         /* NLQ mode                         */
#define NLQ2 4
#define NLQOFF 5
#define SKIP 78                         /* Skip over Perforation            */
#define SKIP1 6                         /* 6 lines                          */
#define SKIPOFF 79
#define LMARG 108                       /* left margin set                  */
#define LMAROFF 0                       /*  left margin reset               */
#define POS10 10                        /*  Print at position  10           */

/*****************************************************************************/
/*                                    global Variables                       */
/*****************************************************************************/
int contrl[12];                         /* Controll-Arrays                  */
int intin[128];
int ptsin[128];
int intout[128];
int ptsout[128];                       /* reserve space for all parameters */
int pxyarray[12];                      /* Array for x,y coordinates        */

int int_in[11];                         /* Input in GSX Array               */
int int_out[57];                        /* Output from GSX Array            */

int handle,i;                           /* virtual workstation handle       */
int phys_handle;                        /* physical workstation handle      */
int wi_handle;                          /* Window handle                    */

int ap_id;                              /* Code number of application       */

int gl_hchar, gl_wchar;                 /* Height and widthof character     */
int gl_wbox, gl_hbox;

int xwork,ywork,wwork,hwork;            /* dimensions of window             */
int xdesk,ydesk,wdesk,hdesk;            /* Desktop dimensions               */
int xold, yold, hold, wold;
                        /* temporary variables for window manipulation*/
int xobj,yobj,wobj,hobj;                /* coordinates of objects           */
int mausx, mausy;                       /* where was mouse when pressed?    */

int dummy;                              /* ... dummy parameter              */

int event;                             /* which event occured at the moment */
int title, item;                       /* Menu title and actual object     */
```

```
/*********************************************************************/
/*                                  Window open, close               */
/*********************************************************************/
open_window()
{
   wi_handle=wind_create(WI_KIND,xdesk,ydesk,wdesk,hdesk);
   graf_growbox(xdesk+wdesk/2,ydesk+hdesk/2,gl_wbox,gl_hbox,xdesk,
                ydesk,wdesk,hdesk);
   wind_open(wi_handle,xdesk,ydesk,wdesk,hdesk);
   wind_get(wi_handle,WF_WORKXYWH,&xwork,&ywork,&wwork,&hwork);
}

close_window()
{
   wind_close(wi_handle);
   graf_shrinkbox(xwork+wwork/2,ywork+hwork/2,gl_wbox,gl_hbox,xwork,
                  ywork,wwork,hwork);
   wind_delete(wi_handle);
}

open_vwork()
{
int i;
      for (i = 1; i <10; i++){
        int_in[i] = 1;       /* init int_in array: line type, color,    */
        }                    /* fill styles usw.                        */
      int_in[10] = 2;        /* use RC - coordinates                    */
      handle=phys_handle;
      v_opnvwk(int_in, &handle, int_out); /* set window ...       */
}

/*********************************************************************/
/*                                  Main program                     */
/*********************************************************************/
main()
{
int ende;                          /* is TRUE when EXIT box selected  */
long  gemdos();                    /* for gemdos-call                 */

      ap_id=appl_init();        /* initialize GEM AES Array-Structures */

      phys_handle=graf_handle(&gl_wchar,&gl_hchar,&gl_wbox,&gl_hbox);
                              /* Parameter for Desktop established     */
      wind_get(0,WF_WORKXYWH,&xdesk,&ydesk,&wdesk,&hdesk);
      open_vwork();                /* Work station opened             */
```

```
      if(!rsrc_load(FILENAME))      /* RSC-file loaded                    */
         {
    form_alert(1,"[3][Bad Copy?|PRINIT.RSC|could not be found.][Abort]");
         close_window;
         desktop();
         }
      if(rsrc_gaddr(0,0,&menu_tree)== 0)
         {
        form_alert(1,"[3] [Fatal error!|Resource File not OK.][Abort]");
         close_window;
         desktop();
         }
      rsrc_gaddr(R_TREE,SGMENU,&menu_tree);
      form_center(menu_tree,&xobj,&yobj,&wobj,&hobj);
      form_dial(0,xobj,yobj,wobj,hobj);
      form_dial(1,1,1,1,1,xobj,yobj,wobj,hobj);

      objc_draw(menu_tree,0,MAX_DEPTH,0,0,wdesk,hdesk);

      graf_mouse(3,&dummy);         /* Mouse = Hand                       */

      while (ende != TRUE){
          event=evnt_button(1,1,1,&mausx,&mausy,&dummy,&dummy);
                                    /* Wait for left button click         */

          item=objc_find(menu_tree,SGMENU,13,mausx,mausy);
                        /* which object in menu_tree at Mouse position*/

          switch(item){
case      ELITEIN:
objc_change(menu_tree,ELITEIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ELITEOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ELITE);
                gemdos(0x5,BELL);
                break;

case      ELITEOUT:
objc_change(menu_tree,ELITEOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ELITEIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ELITEOFF);
                gemdos(0x5,BELL);
                break;
```

```
case    CONDENIN:
objc_change(menu_tree,CONDENIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,CONDENOT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,SMALL);
                gemdos(0x5,BELL);
                break;

case    CONDENOT:
objc_change(menu_tree,CONDENOT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,CONDENIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,SMALLOFF);
                gemdos(0x5,BELL);
                break;

case    PROPIN:
objc_change(menu_tree,PROPIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,PROPOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,PROPORTIONAL);
                gemdos(0x5,PSET);
                gemdos(0x5,BELL);
                break;

    case    PROPOUT:
objc_change(menu_tree,PROPOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,PROPIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,PROPORTIONAL);
                gemdos(0x5,PRESET);
                gemdos(0x5,BELL);
                break;

case    ITALIN:
objc_change(menu_tree,ITALIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ITALOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ITALIC);
                gemdos(0x5,BELL);
                break;
```

```
case     ITALOUT:
objc_change(menu_tree,ITALOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ITALIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
               gemdos(0x5,ESC);
               gemdos(0x5,ITALICOFF);
               gemdos(0x5,BELL);
               break;

case     NLQIN:
objc_change(menu_tree,NLQIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,NLQOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
               gemdos(0x5,ESC);
               gemdos(0x5,NLQ1);
               gemdos(0x5,NLQ2);
               gemdos(0x5,BELL);
               break;

case     NLQOUT:
objc_change(menu_tree,NLQOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,NLQIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
               gemdos(0x5,ESC);
               gemdos(0x5,NLQ1);
               gemdos(0x5,NLQOFF);
               gemdos(0x5,BELL);
               break;

case     SKIPIN:
objc_change(menu_tree,SKIPIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,SKIPOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
               gemdos(0x5,ESC);
               gemdos(0x5,SKIP);
               gemdos(0x5,SKIP1);
               gemdos(0x5,BELL);
               break;

case     SKIPOUT:
objc_change(menu_tree,SKIPOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,SKIPIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
               gemdos(0x5,ESC);
               gemdos(0x5,SKIPOFF);
               gemdos(0x5,BELL);
               break;
```

```
case     MARGIN0:
objc_change(menu_tree,MARGIN0,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,MARGIN10,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,LMARG);
                gemdos(0x5,LMAROFF);
                gemdos(0x5,BELL);
                break;

case     MARGIN10:
objc_change(menu_tree,MARGIN10,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,MARGIN0,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,LMARG);
                gemdos(0x5,POS10);
                gemdos(0x5,BELL);
                break;

case     EXIT:
objc_change(menu_tree,EXIT,0,xwork,ywork,wwork,hwork,SELECTED,1);
                gemdos(0x5,RET);
                form_dial(3,xobj,yobj,wobj,hobj);
                form_dial(2,1,1,1,1,xobj,yobj,wobj,hobj);
                ende=TRUE;
                break;

            } /* End switch  */

      } /* End while */
      desktop();

} /* End main() */

desktop()
{
   v_clsvwk();
   appl_exit();
}
```

If you don't have an SG-10 or Epson-compatible printer you will have to substitute the appropriate codes for your printer in the program.

Small changes, which provide only aesthetic changes are the calls to `graf_growbox` and `graf_shrinkbox` within the window routines. They cause the box to appear to grow and shrink.

Something new is the call to the RSC file. And since `rsrc_load()` is a function, it also returns a function value, namely `TRUE` or `FALSE`. In case of an error in the loading procedure, an alert tree can be displayed and program execution terminated.

An important call is to `rsrc_gaddr()`. This function returns a pointer to the object desired.

Example:

After the start of the program the entire tree must be displayed from first to last object. We must therefore find out where the root of the tree, in our case the `SGMENU` tree, is located in memory.

So we call `rsrc_gaddr()` and tell the AES what we're looking for: namely the object `SGMENU` is a tree `(R_TREE)`. The address of `SGMENU` should be assigned to the pointer `&menu_tree`:

```
rsrc_gaddr(R_TREE,SGMENU,&menu_tree);
```

To display the tree or any other object, we call `Object_Draw`, a function which draws partial sections of a tree:

```
objc_draw(menu_tree,0,MAX_DEPTH,0,0,wdesk,hdesk);
```

The parameters, in order of their occurrence determine which tree is drawn, starting with which object (here zero, the first), up to `chich` (the maximum number can be read under `INFO` in the RCS), and finally a surface which will be prepared for this task.

The call to `Object_Find` within the main loop outputs the number of the object under the mouse pointer after entering the mouse position—which is given as the fourth and fifth parameters of `event_button`. This is then compared to all of our object numbers, for which the symbolic constants stand, in order, until a match is found and the corresponding action is carried out.

The `Object_Change` statements there have no other function then to make the object in question black.

The `form_dial` statemenrts in the program listing display the dialog box. They release the corresponding memory space—the underlying screen area must be saved—draw the growing or shrinking box, and then release the previously occupied memory area again.

For those of you who do not have a C compiler the following BASIC loaders will create the `PRINIT.RCS` and `SGINIT.PRG` programs on your disk.

```
100   rem BASIC loader to create PRINIT.RSC for SG10INIT.PRG
1000  open"R",1,"a:prinit.rsc",16
1010  field#1,16 as bin$
1020  a$="":for i=1 TO 16:read d$:if d$="*"then 1050
1030  a=val("&H"+d$):s=s+a:a$=a$+chr$(a):next
1040  lset bin$=a$:rec=rec+1:put 1,rec:goto 1020
1050  data 00,00,01,E4,00,CC,00,CC,00,CC,00,00,00,24,00,CC
1060  data 00,00,05,14,00,22,00,01,00,0A,00,00,00,00,00,00
1070  data 00,00,05,18,53,47,31,30,20,49,4E,49,54,00,00,00
1080  data 20,20,66,72,6F,6D,3A,20,41,42,41,43,55,53,BA,73
1090  data 20,54,69,70,73,20,26,20,54,72,69,63,6B,73,20,20
1100  data 00,00,00,4A,57,20,31,30,2E,38,35,00,00,00,4F,6B
1110  data 61,79,20,21,00,4F,4E,00,4F,46,46,00,4F,4E,00,4F
1120  data 46,46,00,4F,4E,00,4F,46,46,00,4F,4E,00,4F,46,46
1130  data 00,4F,4E,00,4F,46,46,00,4F,4E,00,4F,46,46,00,31
1140  data 30,00,20,30,00,45,4C,49,54,45,00,00,00,50,52,4F
1150  data 50,00,00,00,49,54,41,4C,49,43,00,00,00,43,4F,4E
1160  data 44,45,4E,00,00,00,4E,4C,51,00,00,00,53,4B,49,50
1170  data 00,00,00,4D,41,52,47,49,4E,00,00,00,00,00,00,24
1180  data 00,00,00,2E,00,00,00,2F,00,03,00,06,00,00,11,80
1190  data 00,00,FF,FF,00,0A,00,01,00,00,00,30,00,00,00,51
1200  data 00,00,00,52,00,05,00,06,00,02,11,A0,00,00,FF,FF
1210  data 00,21,00,01,00,00,00,53,00,00,00,5C,00,00,00,5D
1220  data 00,05,00,06,00,02,11,80,00,00,FF,FF,00,09,00,01
1230  data 00,00,00,95,00,00,00,9B,00,00,00,9C,00,03,00,06
1240  data 00,00,11,60,00,00,FF,FF,00,06,00,01,00,00,00,9D
```

```
1250  data 00,00,00,A2,00,00,00,A3,00,03,00,06,00,00,11,60
1260  data 00,00,FF,FF,00,05,00,01,00,00,00,A4,00,00,00,AB
1270  data 00,00,00,AC,00,03,00,06,00,00,11,60,00,00,FF,FF
1280  data 00,07,00,01,00,00,00,AD,00,00,00,B4,00,00,00,B5
1290  data 00,03,00,06,00,00,11,60,00,00,FF,FF,00,07,00,01
1300  data 00,00,00,B6,00,00,00,BA,00,00,00,BB,00,03,00,06
1310  data 00,00,11,60,00,00,FF,FF,00,04,00,01,00,00,00,BC
1320  data 00,00,00,C1,00,00,00,C2,00,03,00,06,00,00,11,60
1330  data 00,00,FF,FF,00,05,00,01,00,00,00,C3,00,00,00,CA
1340  data 00,00,00,CB,00,03,00,06,00,00,11,60,00,00,FF,FF
1350  data 00,07,00,01,FF,FF,00,01,00,21,00,14,00,00,00,10
1360  data 00,02,11,20,00,00,00,00,00,24,00,13,00,05,00,02
1370  data 00,04,00,14,00,00,00,20,00,FF,33,A2,00,06,00,01
1380  data 00,18,00,03,00,03,FF,FF,FF,FF,00,15,00,00,00,00
1390  data 00,00,00,CC,00,07,00,00,00,09,00,01,00,04,FF,FF
1400  data FF,FF,00,15,00,00,00,00,00,00,00,E8,00,00,00,01
1410  data 00,18,06,00,00,01,FF,FF,FF,FF,00,15,00,00,00,00
1420  data 00,00,01,04,00,09,00,02,00,06,06,00,00,06,FF,FF
1430  data FF,FF,00,1A,00,07,00,00,00,00,00,5E,00,06,00,11
1440  data 00,18,00,01,00,09,00,07,00,08,00,14,00,00,00,20
1450  data 31,FF,11,E1,00,0F,00,06,00,0F,00,01,00,08,FF,FF
1460  data FF,FF,00,1A,00,11,00,00,00,00,00,65,00,00,00,00
1470  data 00,06,00,01,00,06,FF,FF,FF,FF,00,1A,00,11,00,00
1480  data 00,00,00,68,00,0A,00,00,00,05,00,01,00,0C,00,0A
1490  data 00,0B,00,14,00,00,00,20,31,FF,11,61,00,0F,00,07
1500  data 00,0F,00,01,00,0B,FF,FF,FF,FF,00,1A,00,11,00,00
1510  data 00,00,00,6C,00,00,00,00,00,06,00,01,00,09,FF,FF
1520  data FF,FF,00,1A,00,11,00,00,00,00,00,6F,00,0A,00,00
1530  data 00,05,00,01,00,0F,00,0D,00,0E,00,14,00,00,00,20
1540  data 31,FF,11,61,00,0F,00,09,00,0F,00,01,00,0E,FF,FF
1550  data FF,FF,00,1A,00,01,00,00,00,00,00,73,00,00,00,00
1560  data 00,06,00,01,00,0C,FF,FF,FF,FF,00,1A,00,01,00,00
1570  data 00,00,00,76,00,0A,00,00,00,05,00,01,00,12,00,10
1580  data 00,11,00,14,00,00,00,20,31,FF,11,61,00,0F,00,0A
1590  data 00,0F,00,01,00,11,FF,FF,FF,FF,00,1A,00,11,00,00
1600  data 00,00,00,7A,00,00,00,00,00,06,00,01,00,0F,FF,FF
1610  data FF,FF,00,1A,00,11,00,00,00,00,00,7D,00,0A,00,00
1620  data 00,05,00,01,00,15,00,13,00,14,00,14,00,00,00,20
1630  data 31,FF,11,61,00,0F,00,0B,00,0F,00,01,00,14,FF,FF
1640  data FF,FF,00,1A,00,11,00,00,00,00,00,81,00,00,00,00
1650  data 00,06,00,01,00,12,FF,FF,FF,FF,00,1A,00,11,00,00
1660  data 00,00,00,84,00,0A,00,00,00,05,00,01,00,18,00,16
1670  data 00,17,00,14,00,00,00,20,31,FF,11,61,00,0F,00,0D
```

```
1680  data 00,0F,00,01,00,17,FF,FF,FF,FF,00,1A,00,11,00,00
1690  data 00,00,00,88,00,00,00,00,00,06,00,01,00,15,FF,FF
1700  data FF,FF,00,1A,00,11,00,00,00,00,00,8B,00,0A,00,00
1710  data 00,05,00,01,00,1A,00,19,00,19,00,14,00,00,00,20
1720  data 31,FF,11,61,00,0F,00,0E,00,0F,00,01,00,18,FF,FF
1730  data FF,FF,00,1A,00,01,00,00,00,00,00,8F,00,0A,00,00
1740  data 00,05,00,01,00,1B,FF,FF,FF,FF,00,1A,00,11,00,00
1750  data 00,00,00,92,00,0F,00,0E,00,06,00,01,00,1C,FF,FF
1760  data FF,FF,00,16,00,00,00,20,00,00,01,20,00,06,00,06
1770  data 00,08,00,01,00,1D,FF,FF,FF,FF,00,16,00,00,00,20
1780  data 00,00,01,3C,00,06,00,07,00,08,00,01,00,1E,FF,FF
1790  data FF,FF,00,16,00,00,00,20,00,00,01,58,00,06,00,09
1800  data 00,08,00,01,00,1F,FF,FF,FF,FF,00,16,00,00,00,20
1810  data 00,00,01,74,00,06,00,0A,00,08,00,01,00,20,FF,FF
1820  data FF,FF,00,16,00,00,00,20,00,00,01,90,00,06,00,0B
1830  data 00,08,00,01,00,21,FF,FF,FF,FF,00,16,00,00,00,20
1840  data 00,00,01,AC,00,06,00,0D,00,08,00,01,00,00,FF,FF
1850  data FF,FF,00,16,00,20,00,20,00,00,01,C8,00,06,00,0E
1860  data 00,08,00,01,00,00,01,E4,00,00,00,00,00,00,00,00
1870  data *
1880  close 1:if s<> 57208 then print"ERROR IN DATA!":end
1900  print "Ok."
```

```
100   rem BASIC loader to create SG10INIT.PRG
1000  open"R",1,"sg10init.prg",16
1010  field#1,16 as bin$
1020  a$="":for i=1 TO 16:read d$:if d$="*"then 1050
1030  a=val("&H"+d$):s=s+a:a$=a$+chr$(a):next
1040  lset bin$=a$:rec=rec+1:put 1,rec:goto 1020
1050  data 60,1A,00,00,14,30,00,00,02,24,00,00,09,70,00,00
1060  data 00,00,00,00,00,00,00,00,00,00,00,00,2A,4F,2E,7C
1070  data 00,00,1A,54,2A,6D,00,04,20,2D,00,0C,D0,AD,00,14
1080  data D0,AD,00,1C,D0,BC,00,00,01,00,2F,00,2F,0D,3F,00
1090  data 3F,3C,00,4A,4E,41,DF,FC,00,00,00,0C,4E,B9,00,00
1100  data 02,00,2F,3C,00,00,00,00,4E,41,22,2F,00,04,30,3C
1110  data 00,C8,4E,42,4E,75,4E,56,FF,FC,3E,B9,00,00,1F,92
1120  data 3F,39,00,00,1F,BA,3F,39,00,00,1F,C2,3F,39,00,00
1130  data 1F,C0,3F,3C,00,01,4E,B9,00,00,13,36,50,8F,33,C0
1140  data 00,00,1F,B8,3E,B9,00,00,1F,92,3F,39,00,00,1F,BA
1150  data 3F,39,00,00,1F,C2,3F,39,00,00,1F,C0,3F,39,00,00
1160  data 1C,74,3F,39,00,00,1E,A2,30,39,00,00,1F,92,48,C0
1170  data 81,FC,00,02,3F,00,30,39,00,00,1F,C2,D1,57,30,39
1180  data 00,00,1F,BA,48,C0,81,FC,00,02,3F,00,30,39,00,00
1190  data 1F,C0,D1,57,4E,B9,00,00,11,02,DF,FC,00,00,00,0E
1200  data 3E,B9,00,00,1F,92,3F,39,00,00,1F,BA,3F,39,00,00
1210  data 1F,C2,3F,39,00,00,1F,C0,3F,39,00,00,1F,B8,4E,B9
1220  data 00,00,13,70,50,8F,2E,BC,00,00,1C,98,2F,3C,00,00
1230  data 1E,D2,2F,3C,00,00,1E,D6,2F,3C,00,00,1E,D4,3F,3C
1240  data 00,04,3F,39,00,00,1F,B8,4E,B9,00,00,13,DE,DF,FC
1250  data 00,00,00,10,4E,5E,4E,75,4E,56,FF,FC,3E,B9,00,00
1260  data 1F,B8,4E,B9,00,00,13,AA,3E,B9,00,00,1C,98,3F,39
1270  data 00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4
1280  data 3F,39,00,00,1C,74,3F,39,00,00,1E,A2,30,39,00,00
1290  data 1C,98,48,C0,81,FC,00,02,3F,00,30,39,00,00,1E,D6
1300  data D1,57,30,39,00,00,1E,D2,48,C0,81,FC,00,02,3F,00
1310  data 30,39,00,00,1E,D4,D1,57,4E,B9,00,00,11,54,DF,FC
1320  data 00,00,00,0E,3E,B9,00,00,1F,B8,4E,B9,00,00,13,C4
1330  data 4E,5E,4E,75,4E,56,FF,FA,3D,7C,00,01,FF,FE,60,14
1340  data 30,6E,FF,FE,D1,C8,D1,FC,00,00,1E,DA,30,BC,00,01
1350  data 52,6E,FF,FE,0C,6E,00,0A,FF,FE,6D,E4,33,FC,00,02
1360  data 00,00,1E,EE,33,F9,00,00,1C,96,00,00,1C,94,2E,BC
1370  data 00,00,1E,FA,2F,3C,00,00,1C,94,2F,3C,00,00,1E,DA
1380  data 4E,B9,00,00,0E,3E,50,8F,4E,5E,4E,75,4E,56,FF,FA
1390  data 4E,B9,00,00,0F,6E,33,C0,00,00,1E,D8,2E,BC,00,00
1400  data 1C,74,2F,3C,00,00,1E,A2,2F,3C,00,00,1F,74,2F,3C
1410  data 00,00,1F,B6,4E,B9,00,00,11,A6,DF,FC,00,00,00,0C
```

```
1420  data 33,C0,00,00,1C,96,2E,BC,00,00,1F,92,2F,3C,00,00
1430  data 1F,BA,2F,3C,00,00,1F,C2,2F,3C,00,00,1F,C0,3F,3C
1440  data 00,04,42,67,4E,B9,00,00,13,DE,DF,FC,00,00,00,10
1450  data 61,00,FF,42,2E,BC,00,00,15,E4,4E,B9,00,00,12,E8
1460  data 4A,40,66,1C,2E,BC,00,00,15,EF,3F,3C,00,01,4E,B9
1470  data 00,00,10,96,54,8F,20,3C,00,00,01,2C,61,00,0B,6E
1480  data 2E,BC,00,00,1E,CE,42,67,42,67,4E,B9,00,00,13,02
1490  data 58,8F,4A,40,66,1C,2E,BC,00,00,16,24,3F,3C,00,01
1500  data 4E,B9,00,00,10,96,54,8F,20,3C,00,00,01,2C,61,00
1510  data 0B,3C,2E,BC,00,00,1E,CE,42,67,42,67,4E,B9,00,00
1520  data 13,02,58,8F,2E,BC,00,00,1C,76,2F,3C,00,00,1E,A4
1530  data 2F,3C,00,00,1E,C6,2F,3C,00,00,1E,C4,2F,39,00,00
1540  data 1E,CE,4E,B9,00,00,10,B8,DF,FC,00,00,00,10,3E,B9
1550  data 00,00,1C,76,3F,39,00,00,1E,A4,3F,39,00,00,1E,C6
1560  data 3F,39,00,00,1E,C4,42,67,4E,B9,00,00,10,3C,50,8F
1570  data 3E,B9,00,00,1C,76,3F,39,00,00,1E,A4,3F,39,00,00
1580  data 1E,C6,3F,39,00,00,1E,C4,3F,3C,00,01,3F,3C,00,01
1590  data 3F,3C,00,01,3F,3C,00,01,3F,3C,00,01,4E,B9,00,00
1600  data 10,3C,DF,FC,00,00,00,10,3E,B9,00,00,1F,92,3F,39
1610  data 00,00,1F,BA,42,67,42,67,3F,3C,00,22,42,67,2F,39
1620  data 00,00,1E,CE,4E,B9,00,00,12,0A,DF,FC,00,00,00,0E
1630  data 2E,BC,00,00,1C,9A,3F,3C,00,03,4E,B9,00,00,11,E8
1640  data 54,8F,60,00,0A,58,2E,BC,00,00,1C,9A,2F,3C,00,00
1650  data 1C,9A,2F,3C,00,00,1E,9E,2F,3C,00,00,1D,9C,3F,3C
1660  data 00,01,3F,3C,00,01,3F,3C,00,01,4E,B9,00,00,0F,E2
1670  data DF,FC,00,00,00,12,33,C0,00,00,1B,70,3E,B9,00,00
1680  data 1E,9E,3F,39,00,00,1D,9C,3F,3C,00,0D,42,67,2F,39
1690  data 00,00,1E,CE,4E,B9,00,00,12,54,DF,FC,00,00,00,0A
1700  data 33,C0,00,00,1E,A0,30,39,00,00,1E,A0,60,00,09,D8
1710  data 3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1C,98,3F,39
1720  data 00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4
1730  data 42,67,3F,3C,00,07,2F,39,00,00,1E,CE,4E,B9,00,00
1740  data 12,8E,DF,FC,00,00,00,12,3E,BC,00,01,42,67,3F,39
1750  data 00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6
1760  data 3F,39,00,00,1E,D4,42,67,3F,3C,00,08,2F,39,00,00
1770  data 1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC
1780  data 00,1B,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC
1790  data 00,4D,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC
1800  data 00,07,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,60,00
1810  data 09,4C,3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1C,98
1820  data 3F,39,00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00
1830  data 1E,D4,42,67,3F,3C,00,08,2F,39,00,00,1E,CE,4E,B9
1840  data 00,00,12,8E,DF,FC,00,00,00,12,3E,BC,00,01,42,67
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1850  data 3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00
1860  data 1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,07,2F,39
1870  data 00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12
1880  data 3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
1890  data 3E,BC,00,50,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
1900  data 3E,BC,00,07,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
1910  data 60,00,08,AA,3E,BC,00,01,3F,3C,00,01,3F,39,00,00
1920  data 1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6,3F,39
1930  data 00,00,1E,D4,42,67,3F,3C,00,10,2F,39,00,00,1E,CE
1940  data 4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC,00,01
1950  data 42,67,3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39
1960  data 00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,11
1970  data 2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00
1980  data 00,12,3E,BC,00,0F,3F,3C,00,05,4E,B9,00,00,0E,F4
1990  data 54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9,00,00,0E,F4
2000  data 54,8F,60,00,08,18,3E,BC,00,01,3F,3C,00,01,3F,39
2010  data 00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6
2020  data 3F,39,00,00,1E,D4,42,67,3F,3C,00,11,2F,39,00,00
2030  data 1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC
2040  data 00,01,42,67,3F,39,00,00,1C,98,3F,39,00,00,1E,D2
2050  data 3F,39,00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C
2060  data 00,10,2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC
2070  data 00,00,00,12,3E,BC,00,12,3F,3C,00,05,4E,B9,00,00
2080  data 0E,F4,54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9,00,00
2090  data 0E,F4,54,8F,60,00,07,86,3E,BC,00,01,3F,3C,00,01
2100  data 3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00
2110  data 1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,0A,2F,39
2120  data 00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12
2130  data 3E,BC,00,01,42,67,3F,39,00,00,1C,98,3F,39,00,00
2140  data 1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4,42,67
2150  data 3F,3C,00,0B,2F,39,00,00,1E,CE,4E,B9,00,00,12,8E
2160  data DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9
2170  data 00,00,0E,F4,54,8F,3E,BC,00,70,3F,3C,00,05,4E,B9
2180  data 00,00,0E,F4,54,8F,3E,BC,00,01,3F,3C,00,05,4E,B9
2190  data 00,00,0E,F4,54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9
2200  data 00,00,0E,F4,54,8F,60,00,06,D4,3E,BC,00,01,3F,3C
2210  data 00,01,3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39
2220  data 00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,0B
2230  data 2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00
2240  data 00,12,3E,BC,00,01,42,67,3F,39,00,00,1C,98,3F,39
2250  data 00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4
2260  data 42,67,3F,3C,00,0A,2F,39,00,00,1E,CE,4E,B9,00,00
2270  data 12,8E,DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C,00,05
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2280  data 4E,B9,00,00,0E,F4,54,8F,3E,BC,00,70,3F,3C,00,05
2290  data 4E,B9,00,00,0E,F4,54,8F,42,57,3F,3C,00,05,4E,B9
2300  data 00,00,0E,F4,54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9
2310  data 00,00,0E,F4,54,8F,60,00,06,24,3E,BC,00,01,3F,3C
2320  data 00,01,3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39
2330  data 00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,0D
2340  data 2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00
2350  data 00,12,3E,BC,00,01,42,67,3F,39,00,00,1C,98,3F,39
2360  data 00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4
2370  data 42,67,3F,3C,00,0E,2F,39,00,00,1E,CE,4E,B9,00,00
2380  data 12,8E,DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C,00,05
2390  data 4E,B9,00,00,0E,F4,54,8F,3E,BC,00,34,3F,3C,00,05
2400  data 4E,B9,00,00,0E,F4,54,8F,3E,BC,00,07,3F,3C,00,05
2410  data 4E,B9,00,00,0E,F4,54,8F,60,00,05,82,3E,BC,00,01
2420  data 3F,3C,00,01,3F,39,00,00,1C,98,3F,39,00,00,1E,D2
2430  data 3F,39,00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C
2440  data 00,0E,2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC
2450  data 00,00,00,12,3E,BC,00,01,42,67,3F,39,00,00,1C,98
2460  data 3F,39,00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00
2470  data 1E,D4,42,67,3F,3C,00,0D,2F,39,00,00,1E,CE,4E,B9
2480  data 00,00,12,8E,DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C
2490  data 00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC,00,35,3F,3C
2500  data 00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC,00,07,3F,3C
2510  data 00,05,4E,B9,00,00,0E,F4,54,8F,60,00,04,E0,3E,BC
2520  data 00,01,3F,3C,00,01,3F,39,00,00,1C,98,3F,39,00,00
2530  data 1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4,42,67
2540  data 3F,3C,00,13,2F,39,00,00,1E,CE,4E,B9,00,00,12,8E
2550  data DF,FC,00,00,00,12,3E,BC,00,01,42,67,3F,39,00,00
2560  data 1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6,3F,39
2570  data 00,00,1E,D4,42,67,3F,3C,00,14,2F,39,00,00,1E,CE
2580  data 4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC,00,1B
2590  data 3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC,00,42
2600  data 3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC,00,04
2610  data 3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC,00,07
2620  data 3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,60,00,04,2E
2630  data 3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1C,98,3F,39
2640  data 00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00,1E,D4
2650  data 42,67,3F,3C,00,14,2F,39,00,00,1E,CE,4E,B9,00,00
2660  data 12,8E,DF,FC,00,00,00,12,3E,BC,00,01,42,67,3F,39
2670  data 00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6
2680  data 3F,39,00,00,1E,D4,42,67,3F,3C,00,13,2F,39,00,00
2690  data 1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC
2700  data 00,1B,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC
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2710  data 00,42,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC
2720  data 00,05,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,3E,BC
2730  data 00,07,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F,60,00
2740  data 03,7C,3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1C,98
2750  data 3F,39,00,00,1E,D2,3F,39,00,00,1E,D6,3F,39,00,00
2760  data 1E,D4,42,67,3F,3C,00,16,2F,39,00,00,1E,CE,4E,B9
2770  data 00,00,12,8E,DF,FC,00,00,00,12,3E,BC,00,01,42,67
2780  data 3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00
2790  data 1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,17,2F,39
2800  data 00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12
2810  data 3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
2820  data 3E,BC,00,4E,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
2830  data 3E,BC,00,06,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
2840  data 3E,BC,00,07,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
2850  data 60,00,02,CA,3E,BC,00,01,3F,3C,00,01,3F,39,00,00
2860  data 1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6,3F,39
2870  data 00,00,1E,D4,42,67,3F,3C,00,17,2F,39,00,00,1E,CE
2880  data 4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC,00,01
2890  data 42,67,3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39
2900  data 00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,16
2910  data 2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00
2920  data 00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,0E,F4
2930  data 54,8F,3E,BC,00,4F,3F,3C,00,05,4E,B9,00,00,0E,F4
2940  data 54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9,00,00,0E,F4
2950  data 54,8F,60,00,02,28,3E,BC,00,01,3F,3C,00,01,3F,39
2960  data 00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6
2970  data 3F,39,00,00,1E,D4,42,67,3F,3C,00,1A,2F,39,00,00
2980  data 1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC
2990  data 00,01,42,67,3F,39,00,00,1C,98,3F,39,00,00,1E,D2
3000  data 3F,39,00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C
3010  data 00,19,2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC
3020  data 00,00,00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00
3030  data 0E,F4,54,8F,3E,BC,00,6C,3F,3C,00,05,4E,B9,00,00
3040  data 0E,F4,54,8F,42,57,3F,3C,00,05,4E,B9,00,00,0E,F4
3050  data 54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9,00,00,0E,F4
3060  data 54,8F,60,00,01,78,3E,BC,00,01,3F,3C,00,01,3F,39
3070  data 00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00,1E,D6
3080  data 3F,39,00,00,1E,D4,42,67,3F,3C,00,19,2F,39,00,00
3090  data 1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12,3E,BC
3100  data 00,01,42,67,3F,39,00,00,1C,98,3F,39,00,00,1E,D2
3110  data 3F,39,00,00,1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C
3120  data 00,1A,2F,39,00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC
3130  data 00,00,00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00
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3140  data 0E,F4,54,8F,3E,BC,00,6C,3F,3C,00,05,4E,B9,00,00
3150  data 0E,F4,54,8F,3E,BC,00,05,3F,3C,00,05,4E,B9,00,00
3160  data 0E,F4,54,8F,3E,BC,00,07,3F,3C,00,05,4E,B9,00,00
3170  data 0E,F4,54,8F,60,00,00,C6,3E,BC,00,01,3F,3C,00,01
3180  data 3F,39,00,00,1C,98,3F,39,00,00,1E,D2,3F,39,00,00
3190  data 1E,D6,3F,39,00,00,1E,D4,42,67,3F,3C,00,05,2F,39
3200  data 00,00,1E,CE,4E,B9,00,00,12,8E,DF,FC,00,00,00,12
3210  data 3E,BC,00,0D,3F,3C,00,05,4E,B9,00,00,0E,F4,54,8F
3220  data 3E,B9,00,00,1C,76,3F,39,00,00,1E,A4,3F,39,00,00
3230  data 1E,C6,3F,39,00,00,1E,C4,3F,3C,00,03,4E,B9,00,00
3240  data 10,3C,50,8F,3E,B9,00,00,1C,76,3F,39,00,00,1E,A4
3250  data 3F,39,00,00,1E,C6,3F,39,00,00,1E,C4,3F,3C,00,01
3260  data 3F,3C,00,01,3F,3C,00,01,3F,3C,00,01,3F,3C,00,02
3270  data 4E,B9,00,00,10,3C,DF,FC,00,00,00,10,3D,7C,00,01
3280  data FF,FE,60,18,60,16,5B,40,B0,7C,00,15,62,0E,E5,40
3290  data 30,40,D1,FC,00,00,15,8C,20,50,4E,D0,0C,6E,00,01
3300  data FF,FE,66,00,F5,A2,61,C4,4E,5E,4E,75,4E,56,FF,FC
3310  data 4E,B9,00,00,0E,14,4E,B9,00,00,0F,D0,4E,5E,4E,75
3320  data 4E,56,FF,FC,33,FC,00,65,00,00,1F,96,42,79,00,00
3330  data 1F,98,42,79,00,00,1F,9C,33,EE,00,08,00,00,1F,A2
3340  data 4E,B9,00,00,0E,BE,4E,5E,4E,75,4E,56,FF,FC,23,EE
3350  data 00,08,00,00,1A,5C,23,EE,00,10,00,00,1A,64,20,2E
3360  data 00,10,D0,BC,00,00,00,5A,23,C0,00,00,1A,68,33,FC
3370  data 00,64,00,00,1F,96,42,79,00,00,1F,98,33,FC,00,0B
3380  data 00,00,1F,9C,20,6E,00,0C,33,D0,00,00,1F,A2,4E,B9
3390  data 00,00,0E,BE,20,6E,00,0C,30,B9,00,00,1F,A2,23,FC
3400  data 00,00,1A,70,00,00,1A,5C,23,FC,00,00,1B,74,00,00
3410  data 1A,64,23,FC,00,00,1D,9E,00,00,1A,68,23,FC,00,00
3420  data 1C,9C,00,00,1A,60,4E,5E,4E,75,23,FC,00,00,1F,96
3430  data 00,00,1A,58,22,3C,00,00,1A,58,70,73,4E,42,4E,75
3440  data 23,DF,00,00,1A,6C,4E,4E,2F,39,00,00,1A,6C,4E,75
3450  data 23,DF,00,00,1A,6C,4E,4D,2F,39,00,00,1A,6C,4E,75
3460  data 23,DF,00,00,1A,6C,4E,41,2F,39,00,00,1A,6C,4E,75
3470  data 4E,56,FF,F6,33,EE,00,08,00,00,1F,6C,30,2E,00,08
3480  data D0,7C,FF,F6,C1,FC,00,03,48,C0,D0,BC,00,00,14,30
3490  data 2D,40,FF,FA,3D,7C,00,01,FF,FE,60,1E,20,6E,FF,FA
3500  data 10,10,48,80,32,6E,FF,FE,D3,C9,D3,FC,00,00,1F,6C
3510  data 32,80,52,AE,FF,FA,52,6E,FF,FE,0C,6E,00,04,FF,FE
3520  data 6D,DA,2E,B9,00,00,1F,8E,4E,B9,00,00,00,3E,42,40
3530  data 30,39,00,00,1E,FA,4E,5E,4E,75,4E,56,FF,FA,23,FC
3540  data 00,00,1F,6C,00,00,1C,78,23,FC,00,00,1E,A6,00,00
3550  data 1C,7C,23,FC,00,00,1E,DA,00,00,1C,80,23,FC,00,00
3560  data 1E,FA,00,00,1C,84,23,FC,00,00,1F,AE,00,00,1C,88
```

```
3570  data 23,FC,00,00,1F,BC,00,00,1C,8C,23,FC,00,00,1C,78
3580  data 00,00,1F,8E,3E,BC,00,0A,61,00,FF,46,33,F9,00,00
3590  data 1E,FA,00,00,1F,94,70,01,4E,5E,4E,75,4E,56,FF,FC
3600  data 3E,BC,00,13,61,00,FF,2A,70,01,4E,5E,4E,75,4E,56
3610  data FF,FC,33,EE,00,08,00,00,1E,DA,33,EE,00,0A,00,00
3620  data 1E,DC,33,EE,00,0C,00,00,1E,DE,3E,BC,00,15,4E,B9
3630  data 00,00,0F,04,20,6E,00,0E,30,B9,00,00,1E,FC,20,6E
3640  data 00,12,30,B9,00,00,1E,FE,20,6E,00,16,30,B9,00,00
3650  data 1F,00,20,6E,00,1A,30,B9,00,00,1F,02,42,40,30,39
3660  data 00,00,1E,FA,4E,5E,4E,75,4E,56,FF,FC,33,EE,00,08
3670  data 00,00,1E,DA,33,EE,00,0A,00,00,1E,DC,33,EE,00,0C
3680  data 00,00,1E,DE,33,EE,00,0E,00,00,1E,E0,33,EE,00,10
3690  data 00,00,1E,E2,33,EE,00,12,00,00,1E,E4,33,EE,00,14
3700  data 00,00,1E,E6,33,EE,00,16,00,00,1E,E8,33,EE,00,18
3710  data 00,00,1E,EA,3E,BC,00,33,4E,B9,00,00,0F,04,4E,5E
3720  data 4E,75,4E,56,FF,FC,33,EE,00,08,00,00,1E,DA,23,EE
3730  data 00,0A,00,00,1F,AE,3E,BC,00,34,4E,B9,00,00,0F,04
3740  data 4E,5E,4E,75,4E,56,FF,FC,23,EE,00,08,00,00,1F,AE
3750  data 3E,BC,00,36,4E,B9,00,00,0F,04,20,6E,00,0C,30,B9
3760  data 00,00,1E,FC,20,6E,00,10,30,B9,00,00,1E,FE,20,6E
3770  data 00,14,30,B9,00,00,1F,00,20,6E,00,18,30,B9,00,00
3780  data 1F,02,42,40,30,39,00,00,1E,FA,4E,5E,4E,75,4E,56
3790  data FF,FC,33,EE,00,08,00,00,1E,DA,33,EE,00,0A,00,00
3800  data 1E,DC,33,EE,00,0C,00,00,1E,DE,33,EE,00,0E,00,00
3810  data 1E,E0,33,EE,00,10,00,00,1E,E2,33,EE,00,12,00,00
3820  data 1E,E4,33,EE,00,14,00,00,1E,E6,33,EE,00,16,00,00
3830  data 1E,E8,3E,BC,00,49,4E,B9,00,00,0F,04,4E,5E,4E,75
3840  data 4E,56,FF,FC,33,EE,00,08,00,00,1E,DA,33,EE,00,0A
3850  data 00,00,1E,DC,33,EE,00,0C,00,00,1E,DE,33,EE,00,0E
3860  data 00,00,1E,E0,33,EE,00,10,00,00,1E,E2,33,EE,00,12
3870  data 00,00,1E,E4,33,EE,00,14,00,00,1E,E6,33,EE,00,16
3880  data 00,00,1E,E8,3E,BC,00,4A,4E,B9,00,00,0F,04,4E,5E
3890  data 4E,75,4E,56,FF,FC,3E,BC,00,4D,4E,B9,00,00,0F,04
3900  data 20,6E,00,08,30,B9,00,00,1E,FC,20,6E,00,0C,30,B9
3910  data 00,00,1E,FE,20,6E,00,10,30,B9,00,00,1F,00,20,6E
3920  data 00,14,30,B9,00,00,1F,02,42,40,30,39,00,00,1E,FA
3930  data 4E,5E,4E,75,4E,56,FF,FC,33,EE,00,08,00,00,1E,DA
3940  data 23,EE,00,0A,00,00,1F,AE,3E,BC,00,4E,4E,B9,00,00
3950  data 0F,04,4E,5E,4E,75,4E,56,FF,FC,23,FE,00,08,00,00
3960  data 1F,AE,33,EE,00,0C,00,00,1E,DA,33,EE,00,0E,00,00
3970  data 1E,DC,33,EE,00,10,00,00,1E,DE,33,EE,00,12,00,00
3980  data 1E,E0,33,EE,00,14,00,00,1E,E2,33,EE,00,16,00,00
3990  data 1E,E4,3E,BC,00,2A,4E,B9,00,00,0F,04,4E,5E,4E,75
```

```
4000  data 4E,56,FF,FC,23,EE,00,08,00,00,1F,AE,33,EE,00,0C
4010  data 00,00,1E,DA,33,EE,00,0E,00,00,1E,DC,33,EE,00,10
4020  data 00,00,1E,DE,33,EE,00,12,00,00,1E,E0,3E,BC,00,2B
4030  data 4E,B9,00,00,0F,04,4E,5E,4E,75,4E,56,FF,FC,23,EE
4040  data 00,08,00,00,1F,AE,33,EE,00,0C,00,00,1E,DA,33,EE
4050  data 00,0E,00,00,1E,DC,33,EE,00,10,00,00,1E,DE,33,EE
4060  data 00,12,00,00,1E,E0,33,EE,00,14,00,00,1E,E2,33,EE
4070  data 00,16,00,00,1E,E4,33,EE,00,18,00,00,1E,E6,33,EE
4080  data 00,1A,00,00,1E,E8,3E,BC,00,2F,4E,B9,00,00,0F,04
4090  data 4E,5E,4E,75,4E,56,FF,FC,23,EE,00,08,00,00,1F,AE
4100  data 3E,BC,00,6E,4E,B9,00,00,0F,04,4E,5E,4E,75,4E,56
4110  data FF,FC,33,EE,00,08,00,00,1E,DA,33,EE,00,0A,00,00
4120  data 1E,DC,3E,BC,00,70,4E,B9,00,00,0F,04,20,6E,00,0C
4130  data 20,B9,00,00,1F,BC,42,40,30,39,00,00,1E,FA,4E,5E
4140  data 4E,75,4E,56,FF,FC,33,EE,00,08,00,00,1E,DA,33,EE
4150  data 00,0A,00,00,1E,DC,33,EE,00,0C,00,00,1E,DE,33,EE
4160  data 00,0E,00,00,1E,E0,33,EE,00,10,00,00,1E,E2,3E,BC
4170  data 00,64,4E,B9,00,00,0F,04,4E,5E,4E,75,4E,56,FF,FC
4180  data 33,EE,00,08,00,00,1E,DA,33,EE,00,0A,00,00,1E,DC
4190  data 33,EE,00,0C,00,00,1E,DE,33,EE,00,0E,00,00,1E,E0
4200  data 33,EE,00,10,00,00,1E,E2,3E,BC,00,65,4E,B9,00,00
4210  data 0F,04,4E,5E,4E,75,4E,56,FF,FC,33,EE,00,08,00,00
4220  data 1E,DA,3E,BC,00,66,4E,B9,00,00,0F,04,4E,5E,4E,75
4230  data 4E,56,FF,FC,33,EE,00,08,00,00,1E,DA,3E,BC,00,67
4240  data 4E,B9,00,00,0F,04,4E,5E,4E,75,4E,56,FF,FC,33,EE
4250  data 00,08,00,00,1E,DA,33,EE,00,0A,00,00,1E,DC,3E,BC
4260  data 00,68,4E,B9,00,00,0F,04,20,6E,00,0C,30,B9,00,00
4270  data 1E,FC,20,6E,00,10,30,B9,00,00,1E,FE,20,6E,00,14
4280  data 30,B9,00,00,1F,00,20,6E,00,18,30,B9,00,00,1F,02
4290  data 42,40,30,39,00,00,1E,FA,4E,5E,4E,75,00,01,00,02
4300  data 01,01,02,01,01,00,01,01,02,01,01,01,01,01,00,00
4310  data 00,00,00,00,00,00,00,00,01,00,00,01,00,03,05,00
4320  data 05,05,00,00,01,01,02,01,00,10,07,01,02,01,00,00
4330  data 00,00,00,00,00,00,00,00,01,01,01,02,01,01,02,01
4340  data 01,02,01,01,01,01,02,01,01,01,00,00,00,00,00,00
4350  data 00,00,00,00,00,00,02,01,01,01,01,01,06,01,01,04
4360  data 01,01,01,03,01,02,01,01,04,02,01,08,01,01,00,00
4370  data 00,00,00,00,01,01,01,09,01,01,01,01,01,01,01,00
4380  data 00,05,01,00,00,00,00,00,00,00,00,00,00,00,00,00
4390  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4400  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4410  data 04,03,00,08,03,00,06,01,00,08,01,00,08,01,00,04
4420  data 01,01,03,01,01,00,05,00,01,01,01,00,05,00,00,01
```

```
4430  data 01,00,01,01,00,00,00,00,00,00,00,00,00,00,00,00
4440  data 00,00,00,00,00,00,00,00,00,00,00,00,02,02,00
4450  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4460  data 00,00,00,00,00,00,00,00,00,00,05,01,00,05,01,00
4470  data 01,01,00,01,01,00,02,05,00,06,01,00,02,01,00,01
4480  data 01,00,06,05,00,00,00,00,00,01,01,00,01,00,02,01
4490  data 00,02,01,01,01,01,01,00,00,00,00,00,00,00,00,00
4500  data 00,00,00,00,00,00,00,01,02,03,01,02,01,01,01,01
4510  data 01,01,00,01,01,00,01,02,00,00,0D,2C,00,00,0D,F0
4520  data 00,00,04,04,00,00,04,A6,00,00,0D,F0,00,00,06,6C
4530  data 00,00,07,1E,00,00,0D,F0,00,00,07,CE,00,00,08,70
4540  data 00,00,0D,F0,00,00,05,48,00,00,05,DA,00,00,0D,F0
4550  data 00,00,09,12,00,00,09,C4,00,00,0D,F0,00,00,0A,76
4560  data 00,00,0B,28,00,00,0D,F0,00,00,0C,7A,00,00,0B,CA
4570  data 50,52,49,4E,49,54,2E,52,53,43,00,5B,33,5D,5B,42
4580  data 61,64,20,43,6F,70,79,3F,7C,50,52,49,4E,49,54,2E
4590  data 52,53,43,7C,63,6F,75,6C,64,20,6E,6F,74,20,62,65
4600  data 20,66,6F,75,6E,64,2E,5D,5B,41,62,6F,72,74,5D,00
4610  data 5B,33,5D,20,5B,46,61,74,61,6C,20,65,72,72,6F,72
4620  data 21,7C,52,65,73,6F,75,72,63,65,20,46,69,6C,65,20
4630  data 6E,6F,74,20,4F,4B,2E,5D,5B,41,62,6F,72,74,5D,00
4640  data 00,00,00,04,2E,1E,06,06,06,0A,08,06,06,06,06,06
4650  data 06,06,0E,08,0E,08,0C,06,06,06,06,06,08,06,06,06
4660  data 0A,06,14,06,06,06,06,06,06,06,06,0E,08,0E,08,0C
4670  data 06,1C,18,06,04,06,06,06,06,10,06,06,06,06,06,06
4680  data 0C,06,06,06,06,0C,10,06,0A,0A,08,0A,0A,0C,0A,08
4690  data 0A,0A,08,06,06,06,06,06,0C,06,06,06,08,08,06,06
4700  data 06,1A,0C,06,10,06,0C,0A,0C,06,06,06,12,0C,06,06
4710  data 0C,06,0C,06,12,06,06,06,0C,06,12,06,06,06,0C,06
4720  data 14,10,10,14,06,06,06,0C,06,12,06,06,06,0C,06,14
4730  data 10,10,14,06,06,06,0C,06,12,06,06,06,0C,06,14,10
4740  data 14,06,06,06,0C,06,12,06,06,06,0C,06,14,10,14,06
4750  data 06,06,0C,06,12,06,06,06,0C,06,14,10,10,10,14,06
4760  data 06,06,0C,06,12,06,06,06,0C,06,14,10,0E,10,14,06
4770  data 06,06,0C,06,12,06,06,06,0C,06,14,10,10,14,06,06
4780  data 06,0C,06,12,06,06,06,0C,06,14,10,10,14,06,06,06
4790  data 0C,06,12,06,06,06,0C,06,14,10,10,10,14,06,06,06
4800  data 0C,06,12,06,06,06,0C,06,14,10,10,10,14,06,06,06
4810  data 0C,06,12,06,06,06,0C,06,14,10,10,10,14,06,06,06
4820  data 0C,06,12,06,06,06,0C,06,14,10,10,14,06,06,06,0C
4830  data 06,12,06,06,06,0C,06,14,10,0E,10,14,06,06,06,0C
4840  data 06,12,06,06,06,0C,06,14,10,10,10,14,06,06,06,0C
4850  data 06,14,08,06,06,06,0A,08,06,06,06,1A,22,1E,06,10
```

```
4860  data 06,06,08,06,10,08,10,08,06,08,0A,06,0A,06,04,06
4870  data 04,06,04,06,04,0A,04,06,0C,08,08,08,08,08,0E,14
4880  data 20,18,06,08,0E,04,06,04,06,04,06,04,06,04,06,04
4890  data 06,04,0E,04,24,08,08,0A,0A,0A,0A,0A,08,10,08,08
4900  data 08,08,08,08,08,08,0A,10,08,0A,10,0A,0A,0A,0A,0A
4910  data 08,10,08,08,08,08,08,08,08,0A,10,08,08,08,08,08
4920  data 08,08,0A,12,0A,0A,0A,0A,08,10,08,0A,10,08,08,08
4930  data 08,08,08,0A,10,08,08,08,08,0A,10,08,08,08,08,08
4940  data 08,08,08,0A,10,0A,10,08,0A,0A,08,10,08,08,08,08
4950  data 0A,10,08,08,08,08,0A,10,0A,10,0A,10,08,0A,0A,0A
4960  data 0A,0A,08,01,66,04,04,04,04,04,04,04,04,04,04,04
4970  data 04,04,04,04,04,04,04,04,04,04,00,00,00,00,00,00
4980  data *
4990  close 1:if s<> 371988 then print"ERROR IN DATA!":end
5010  print "Ok."
```

## 4.5 PRINIT as a desk accessory

To install the application as an accessory, a number of changes are necessary. This desk accessory program sets several parameters for an Epson FX-80 printer. An accessory should limit itself to one window, and it should not be larger than the actual dialog box. It doesn't matter much if the accessory can be moved around the screen since it is called for only a short time. This saves some programming work, memory space and loading time. The only function calls we need in the `open_window` area are `wind_create` and `wind_get`. For those who would really like to have a window, the necessary source code is included in the listing as comment lines.

To make an accessory accessable from the desk menu, the procedure `menu_register` is used. As parameters it requires the ID code of the application (from `appl_init`) and a string under which the program is to appear on the menu. As the result, `menu_register` returns a number between zero and five, which corresponds to an accessory ID code.

But in order to get this far, the program must be started. This takes place after loading the operating system. The user doesn't notice this because the workstation has not yet been opened.

After this phase of the intitialization, the accessory issues an `evnt_multi` for all events, so as not to interfere with the main program. There it waits for a message event to return the actual accessory ID in the message buffer.

As we explained before, the code of the calling application is in `msgbuff(4)`, that is, if the condition,

```
if (msgbuff(4) == menu_id)
```

returns `TRUE`, the user has called the accessory in question.

Now the workstation and the window are opened and a branch made to the actual program (here `output();`). This corresponds to a normal application. The only thing to note is to declare the termination as `FALSE`; this can happen before the program is exited (not ended!), or at the beginning of the main loop, or else it would be possible to call the accessory again.

The most important thing to remember is that execution of an accessory is never ended, and you will never find an `appl_exit`. Accessories always run under multi-tasking operation, that is, every accessory is placed on the *ready* list and the `evnt_multi` takes care of each accessory.

The structure of such an `event_multi` call looks like this:

```
while (TRUE)
    ... event_multi /* read event */
    ... Message_event /* for this accessory? */
        ... if yes: is it actual menu_id ?
            ... if yes: start function
        ... if no: keep waiting for Message_event
    ... if no: keep waiting for Message_event
... /* end while */
```

There may never be a statement within all of the program code that could interrupt this loop. This is why the condition is just `TRUE`, which is naturally always the case! For an accessory the `evnt_multi` call must always be available.

Next you must change the resource file using the RSC. Rename the dialog tree to FXMENU. Change the `NLQIN` and `NLQOUT` to `MICROIN` and `MICROOUT`. Change the text `NLQ` to `MICRO`. We will substitute the super script feature of the FX-80 instead of the near letter quality mode of the SG-10. By comparing the printer initialization listings in the two C programs you should be able to adapt these programs to any printer.

In the desk accessory the dialog box is handled with the `form_do` function. This function gives control to the AES and monitors all input to the dialog box. The `form_do` function only returns a value on an *exit* so change the `ON, OFF, 0, 10` buttons in the resource file to `SELECTED, RADIO BUTN` and `TOUCHEXIT`. Now we can replace our `event_button` call with the `form_do` function. This allows input only in the dialog box making sure that our desk accessory does not allow windows to be opened over it.

The printer's bell has also been removed for silent operation of the accessory.

```
/*********************************************************************/
/******                    PROGRAM: PR-INIT                      **********/
/****** Initialize ACCESSORY for printer in parallel port   **********/
/******      (c) J. Walkowiak, 4. November 1985              ********/
/*********************************************************************/
#include "obdefs.h"                 /* Object definitions              */
#include "gemdefs.h"                /* Definitions for  GEM            */
#include "define.h"
#include "gembind.h"
#include "vdibind.h"

/*********************************************************************/
/*                                  Definitions for RSC-File         */
/*********************************************************************/
#define FILENAME "PRINIT.RSC"       /* Name of RSC-file                */
#define MAX_DEPTH 34              /* Number of all objects, Char. depth */
#define FXMENU 0                    /* TREE                            */
#define EXIT 5                      /* OBJECT in TREE #0               */
#define ELITEIN 7                   /* OBJECT in TREE #0               */
#define ELITEOUT 8                  /* OBJECT in TREE #0               */
#define PROPIN 10                   /* OBJECT in TREE #0               */
#define PROPOUT 11                  /* OBJECT in TREE #0               */
#define ITALIN 13                   /* OBJECT in TREE #0               */
#define ITALOUT 14                  /* OBJECT in TREE #0               */
#define CONDENIN 16                 /* OBJECT in TREE #0               */
#define CONDENOT 17                 /* OBJECT in TREE #0               */
#define MICROIN 19                  /* OBJECT in TREE #0               */
#define MICROOUT 20                 /* OBJECT in TREE #0               */
#define SKIPIN 22                   /* OBJECT in TREE #0               */
#define SKIPOUT 23                  /* OBJECT in TREE #0               */
#define MARG0 26                    /* OBJECT in TREE #0               */
#define MARG10 25                   /* OBJECT in TREE #0               */

long menu_tree;                     /* Address of desired RSC-Object   */

/*********************************************************************/
/*                        Definitions of BUTTON-types in Menu        */
/*********************************************************************/
#define SELECTED 0x0001
#define NORMAL 0x0000


/*********************************************************************/
/*                                  Printer control codes            */
/*                                   here: EPSON FX-80+              */
/*********************************************************************/
```

```
#define RET 13                  /* Return                          */
#define ESC 27                  /* Escape                          */
#define SMALL 15                /* Condensed type                  */
#define SMALLOFF 18
#define ELITE 77                /* Elite                           */
#define ELITEOFF 80
#define PROPORTIONAL 112        /* Proportional type:              */
#define PSET 1                  /*  on                             */
#define PRESET 0                /*  off                            */
#define ITALIC 52               /* Italics                         */
#define ITALICOFF 53
#define MICRO1 83               /* Super script1                   */
#define MICRO2 0
#define MICROOFF 84
#define SKIP 78                 /* Skip over Perforation           */
#define SKIP1 6                 /* skip 6 lines         */
#define SKIPOFF 79
#define LMARG 108               /* Set left margin                 */
#define LMAROFF 0               /*  Count from the right           */
#define POS10 10                /*  Print at position 10           */

#define NO_WINDOW (-1)

#define MIN_WIDTH (2*gl_wbox)
#define MIN_HEIGHT (3*gl_box)

/*****************************************************************/
/*                      global variables                         */
/*****************************************************************/
int contrl(12);                 */ control arrays               */
int intin[128];
int ptsin[128];
int intout[128];
int ptsout[128];        /* Sufficient memory for all circumstances*/
int pxyarray[12];       /* Array for x,y coordinates           */

int work_in[11];        /* Input in GSX array                   */
int work_out[57];       /* Output from GSX array                */


int handle,i;          /* virtual workstation handle           */
int phys_handle;       /* physical workstation handle          */
int wi_handle;         /* Window handle                        */

extern gl_apid;        /* Application identifier               */
extern long gemdos();  /* for GEMDOS-Call                     */
```

```
int menu_id;            /* Accessory marker in Desk menu          */

int gl_hchar, gl_wchar;  /* Character height & width               */
int gl_wbox, gl_hbox;

int xwork,ywork,wwork,hwork;       /* Size of working window       */
int xdesk,ydesk,wdesk,hdesk;       /* Size of desktop              */
int xold, yold, hold, wold;  /* Help variables by window  manipulation*/
int xobj,yobj,wobj,hobj;           /* Size of an object            */
int mausx, mausy;                  /* Where is the mouse ?         */

int dummy;                         /* ... for dummy parameter     */

int event;                         /* Which input device           */
int msgbuff[8];
int title, item;                   /* Menu title and current object */

int ende;



int   top_window;   /* handle of topped window */

int   keycode;      /* keycode returned by event-keyboard */
int   mx,my;        /* mouse x and y pos. */
int   butdown;      /* button state tested for, UP/DOWN */
int   ret;          /* dummy return variable */

int   hidden;       /* current state of cursor */

int   fulled;       /* current state of window */


/*****************************************************************/
/* open virtual workstation                                      */
/*****************************************************************/
open_vwork()
{
int i;
   for(i=0;i<10;work_in[i++]=1);
   work_in[10]=2;
   handle=phys_handle;
   v_opnvwk(work_in,&handle,work_out);
}
```

```
/*****************************************************************/
/* open window                                                   */
/*****************************************************************/
open_window()
{
   wi_handle=wind_create(0x0000,xobj,yobj,wobj,hobj);
                          /* Window only as big as dialog box  (obj)*/

/*    wind_set(wi_handle, WF_NAME," name goes here ",0,0);  only when
window w/ title line

graf_growbox(xdesk+wdesk/2,ydesk+hdesk/2,gl_wbox,gl_hbox,xdesk,ydesk,wde
sk,hdesk);*/

   wind_open(wi_handle,xobj,yobj,wobj,hobj);
                            /* Open work window                    */
   wind_get(wi_handle,WF_WORKXYWH,&xwork,&ywork,&wwork,&hwork);
}


/*****************************************************************/
/*      Accessory Init. Until First Event_Multi                  */
/*****************************************************************/
main()
{
   appl_init();
   phys_handle=graf_handle(&gl_wchar,&gl_hchar,&gl_wbox,&gl_hbox);
   menu_id=menu_register(gl_apid,"  FX-80+ INIT");
   wind_get(0, WF_WORKXYWH, &xdesk, &ydesk, &wdesk, &hdesk);

      if(!rsrc_load(FILENAME))     /* Load RSC-file                 */
         {
              form_alert(1,"[3][Bad copy? |PRINIT.RSC| couldn't be
found!][Cancel]");
         }
      if(rsrc_gaddr(0,0,&menu_tree)== 0)
         {
               form_alert(1,"[3] [Fatal error!!|Resource File not
OK.][Cancel]");
         }

      rsrc_gaddr(R_TREE,FXMENU,&menu_tree);
      form_center(menu_tree,&xobj,&yobj,&wobj,&hobj);

   multi();
}
```

```
    while (TRUE) {
       event = evnt_multi (MU_MESAG | MU_BUTTON | MU_KEYBD,
          1,1,1,
          0,0,0,0,0,
          0,0,0,0,0,
          msgbuff,0,0,&mausx,&mausy,&dummy,&dummy,
          &dummy,&dummy);


    if (event & MU_MESAG)
       switch (msgbuff[0]) {

          case AC_OPEN:
             if (msgbuff[4] == menu_id) {
                 open_vwork();
                 open_window();
                 output();
                 wind_close(wi_handle);
                 wind_delete(wi_handle);
                 v_clsvwk(handle);
             }
             break;
        }   /* switch */
    } /*while TRUE */
)

output()
{
       rsrc_gaddr(R_TREE,FXMENU,&menu_tree);
       form_center(menu_tree,&xobj,&yobj,&wobj,&hobj);
       form_dial(0,xobj,yobj,wobj,hobj);
       form_dial(1,1,1,1,1,xobj,yobj,wobj,hobj);

       objc_draw(menu_tree,0,MAX_DEPTH,0,0,wdesk,hdesk);

       ende = FALSE;                  /* Otherwise, just one run          */
       while (ende != TRUE){

              item = form_do(menu_tree,FXMENU);
                           /*returns obj. number on exit*/

/* removed to use form_do all selected objects must be TOUCHEXIT or EXIT
         event=evnt_button(1,1,1,&mausx,&mausy,&dummy,&dummy);
           item=objc_find(menu_tree,FXMENU,13,mausx,mausy);
                      which object in menu_tree is at mouse pos */
```

```
          switch(item){

case      ELITEIN:
objc_change(menu_tree,ELITEIN,0,xobj,yobj,wobj,hobj,SELECTED,1);

objc_change(menu_tree,ELITEOUT,0,xobj,yobj,wobj,hobj,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ELITE);
                break;

case      ELITEOUT:
objc_change(menu_tree,ELITEOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ELITEIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ELITEOFF);
                break;

case      CONDENIN:
objc_change(menu_tree,CONDENIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,CONDENOT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,SMALL);
                break;

case      CONDENOT:
objc_change(menu_tree,CONDENOT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,CONDENIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,SMALLOFF);
                break;

    case      PROPIN:
objc_change(menu_tree,PROPIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,PROPOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,PROPORTIONAL);
                gemdos(0x5,PSET);
                break;

case      PROPOUT:
objc_change(menu_tree,PROPOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,PROPIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,PROPORTIONAL);
```

```
                gemdos(0x5,PRESET);
                break;


case      ITALIN:
objc_change(menu_tree,ITALIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ITALOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ITALIC);
                break;

case     ITALOUT:
objc_change(menu_tree,ITALOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,ITALIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,ITALICOFF);
                break;

case      MICROIN:
objc_change(menu_tree,MICROIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,MICROOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,MICRO1);
                gemdos(0x5,MICRO2);
                break;

case      MICROOUT:
objc_change(menu_tree,MICROOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,MICROIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,MICROOFF);
                break;

case      SKIPIN:
objc_change(menu_tree,SKIPIN,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,SKIPOUT,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,SKIP);
                gemdos(0x5,SKIP1);
                break;
```

```
case     SKIPOUT:
objc_change(menu_tree,SKIPOUT,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,SKIPIN,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,SKIPOFF);
                break;

case     MARG0:
objc_change(menu_tree,MARG0,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,MARG10,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,LMARG);
                gemdos(0x5,LMAROFF);
                break;

case     MARG10:
objc_change(menu_tree,MARG10,0,xwork,ywork,wwork,hwork,SELECTED,1);

objc_change(menu_tree,MARG0,0,xwork,ywork,wwork,hwork,NORMAL,1);
                gemdos(0x5,ESC);
                gemdos(0x5,LMARG);
                gemdos(0x5,POS10);
                break;

case     EXIT:
objc_change(menu_tree,EXIT,0,xwork,ywork,wwork,hwork,SELECTED,1);
                gemdos(0x5,RET);
                form_dial(2,xobj,yobj,wobj,hobj);
                form_dial(3,1,1,1,1,xobj,yobj,wobj,hobj);
                ende=TRUE;

objc_change(menu_tree,EXIT,0,xwork,ywork,wwork,hwork,NORMAL,1);
        /* Return; otherwise, a break on the next accessory call     */
                break;

            } /* End switch  */

      } /* End while */
}
```

For those of you who don't have a C compiler, the following BASIC loaders will create the files PRINIT.RSC and FX80INIT.ACC on your disk.

```
 100   ' BASIC loader to create PRINIT.RSC for FX80INIT.ACC
1000  open"R",1,"a:prinit.rsc",16
1010  field#1,16 as bin$
1020  a$="":for i=1 TO 16:read d$:if d$="*"then 1050
1030  a=val("&H"+d$):s=s+a:a$=a$+chr$(a):next
1040  lset bin$=a$:rec=rec+1:put 1,rec:goto 1020
1050  data 00,00,01,E8,00,D0,00,D0,00,D0,00,00,00,24,00,D0
1060  data 00,00,05,18,00,22,00,01,00,0A,00,00,00,00,00,00
1070  data 00,00,05,1C,46,58,2D,38,30,2B,20,49,4E,49,54,00
1080  data 00,00,20,20,66,72,6F,6D,3A,20,41,42,41,43,55,53
1090  data BA,73,20,54,69,70,73,20,26,20,54,72,69,63,6B,73
1100  data 20,20,00,00,00,4A,57,20,31,30,2E,38,35,00,00,00
1110  data 4F,6B,61,79,20,21,00,4F,4E,00,4F,46,46,00,4F,4E
1120  data 00,4F,46,46,00,4F,4E,00,4F,46,46,00,4F,4E,00,4F
1130  data 46,46,00,4F,4E,00,4F,46,46,00,4F,4E,00,4F,46,46
1140  data 00,31,30,00,20,30,00,45,4C,49,54,45,00,00,00,50
1150  data 52,4F,50,00,00,00,49,54,41,4C,49,43,00,00,00,43
1160  data 4F,4E,44,45,4E,00,00,00,4D,49,43,52,4F,00,00,00
1170  data 53,4B,49,50,00,00,00,4D,41,52,47,49,4E,00,00,00
1180  data 00,00,00,24,00,00,00,30,00,00,00,31,00,03,00,06
1190  data 00,00,11,80,00,00,FF,FF,00,0C,00,01,00,00,00,32
1200  data 00,00,00,53,00,00,00,54,00,05,00,06,00,02,11,A0
1210  data 00,00,FF,FF,00,21,00,01,00,00,00,55,00,00,00,5E
1220  data 00,00,00,5F,00,05,00,06,00,02,11,80,00,00,FF,FF
1230  data 00,09,00,01,00,00,00,97,00,00,00,9D,00,00,00,9E
1240  data 00,03,00,06,00,00,11,60,00,00,FF,FF,00,06,00,01
1250  data 00,00,00,9F,00,00,00,A4,00,00,00,A5,00,03,00,06
1260  data 00,00,11,60,00,00,FF,FF,00,05,00,01,00,00,00,A6
1270  data 00,00,00,AD,00,00,00,AE,00,03,00,06,00,00,11,60
1280  data 00,00,FF,FF,00,07,00,01,00,00,00,AF,00,00,00,B6
1290  data 00,00,00,B7,00,03,00,06,00,00,11,60,00,00,FF,FF
1300  data 00,07,00,01,00,00,00,B8,00,00,00,BE,00,00,00,BF
1310  data 00,03,00,06,00,00,11,60,00,00,FF,FF,00,06,00,01
1320  data 00,00,00,C0,00,00,00,C5,00,00,00,C6,00,03,00,06
1330  data 00,00,11,60,00,00,FF,FF,00,05,00,01,00,00,00,C7
1340  data 00,00,00,CE,00,00,00,CF,00,03,00,06,00,00,11,60
1350  data 00,00,FF,FF,00,07,00,01,FF,FF,00,01,00,21,00,14
1360  data 00,00,00,10,00,02,11,20,00,00,00,00,00,24,00,13
1370  data 00,05,00,02,00,04,00,14,00,00,00,20,00,FF,33,A2
```

```
1380  data 00,06,00,01,00,18,00,03,00,03,FF,FF,FF,FF,00,15
1390  data 00,00,00,00,00,00,00,D0,00,07,00,00,00,0B,00,01
1400  data 00,04,FF,FF,FF,FF,00,15,00,00,00,00,00,00,00,EC
1410  data 00,00,00,01,00,18,06,00,00,01,FF,FF,FF,FF,00,15
1420  data 00,00,00,00,00,00,01,08,00,09,00,02,00,06,06,00
1430  data 00,06,FF,FF,FF,FF,00,1A,00,07,00,00,00,00,00,60
1440  data 00,06,00,11,00,18,00,01,00,09,00,07,00,08,00,14
1450  data 00,00,00,20,31,FF,11,E1,00,0F,00,06,00,0F,00,01
1460  data 00,08,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,67
1470  data 00,00,00,00,00,06,00,01,00,06,FF,FF,FF,FF,00,1A
1480  data 00,51,00,00,00,00,00,6A,00,0A,00,00,00,05,00,01
1490  data 00,0C,00,0A,00,0B,00,14,00,00,00,20,31,FF,11,61
1500  data 00,0F,00,07,00,0F,00,01,00,0B,FF,FF,FF,FF,00,1A
1510  data 00,51,00,00,00,00,00,6E,00,00,00,00,00,06,00,01
1520  data 00,09,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,71
1530  data 00,0A,00,00,00,05,00,01,00,0F,00,0D,00,0E,00,14
1540  data 00,00,00,20,31,FF,11,61,00,0F,00,09,00,0F,00,01
1550  data 00,0E,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,75
1560  data 00,00,00,00,00,06,00,01,00,0C,FF,FF,FF,FF,00,1A
1570  data 00,51,00,00,00,00,00,78,00,0A,00,00,00,05,00,01
1580  data 00,12,00,10,00,11,00,14,00,00,00,20,31,FF,11,61
1590  data 00,0F,00,0A,00,0F,00,01,00,11,FF,FF,FF,FF,00,1A
1600  data 00,51,00,00,00,00,00,7C,00,00,00,00,00,06,00,01
1610  data 00,0F,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,7F
1620  data 00,0A,00,00,00,05,00,01,00,15,00,13,00,14,00,14
1630  data 00,00,00,20,31,FF,11,61,00,0F,00,0B,00,0F,00,01
1640  data 00,14,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,83
1650  data 00,00,00,00,00,06,00,01,00,12,FF,FF,FF,FF,00,1A
1660  data 00,51,00,00,00,00,00,86,00,0A,00,00,00,05,00,01
1670  data 00,18,00,16,00,17,00,14,00,00,00,20,31,FF,11,61
1680  data 00,0F,00,0D,00,0F,00,01,00,17,FF,FF,FF,FF,00,1A
1690  data 00,51,00,00,00,00,00,8A,00,00,00,00,00,06,00,01
1700  data 00,15,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,8D
1710  data 00,0A,00,00,00,05,00,01,00,1A,00,19,00,19,00,14
1720  data 00,00,00,20,31,FF,11,61,00,0F,00,0E,00,0F,00,01
1730  data 00,18,FF,FF,FF,FF,00,1A,00,51,00,00,00,00,00,91
1740  data 00,0A,00,00,00,05,00,01,00,1B,FF,FF,FF,FF,00,1A
1750  data 00,51,00,00,00,00,00,94,00,0F,00,0E,00,06,00,01
1760  data 00,1C,FF,FF,FF,FF,00,16,00,00,00,20,00,00,01,24
1770  data 00,06,00,06,00,08,00,01,00,1D,FF,FF,FF,FF,00,16
1780  data 00,00,00,20,00,00,01,40,00,06,00,07,00,08,00,01
1790  data 00,1E,FF,FF,FF,FF,00,16,00,00,00,20,00,00,01,5C
1800  data 00,06,00,09,00,08,00,01,00,1F,FF,FF,FF,FF,00,16
```

```
1810  data 00,00,00,20,00,00,01,78,00,06,00,0A,00,08,00,01
1820  data 00,20,FF,FF,FF,FF,00,16,00,00,00,20,00,00,01,94
1830  data 00,06,00,0B,00,08,00,01,00,21,FF,FF,FF,FF,00,16
1840  data 00,00,00,20,00,00,01,B0,00,06,00,0D,00,08,00,01
1850  data 00,00,FF,FF,FF,FF,00,16,00,20,00,20,00,00,01,CC
1860  data 00,06,00,0E,00,08,00,01,00,00,01,E8,00,00,00,00
1870  data *
1880  close 1:if s<> 58576 then print"ERROR IN DATA!":end
1900  print "Ok."
```

```
1000  open"R",1,"c:fx80acc.acc",16
1010  field#1,16 as bin$
1020  a$="":for i=1 TO 16:read d$:if d$="*"then 1050
1030  a=val("&H"+d$):s=s+a:a$=a$+chr$(a):next
1040  lset bin$=a$:rec=rec+1:put 1,rec:goto 1020
1050  data 60,1A,00,00,12,DC,00,00,02,36,00,00,09,BA,00,00
1060  data 00,00,00,00,00,00,00,00,00,00,00,00,2E,7C,00,00
1070  data 19,16,4E,B9,00,00,00,FA,2E,BC,00,00,00,00,4E,41
1080  data 22,2F,00,04,30,3C,00,C8,4E,42,4E,75,4E,56,FF,FA
1090  data 42,6E,FF,FE,60,14,30,6E,FF,FE,D1,C8,D1,FC,00,00
1100  data 1D,AE,30,BC,00,01,52,6E,FF,FE,0C,6E,00,0A,FF,FE
1110  data 6D,E4,33,FC,00,02,00,00,1D,C2,33,F9,00,00,1B,70
1120  data 00,00,1B,6E,2E,BC,00,00,1E,06,2F,3C,00,00,1B,6E
1130  data 2F,3C,00,00,1D,AE,4E,B9,00,00,0D,22,50,8F,4E,5E
1140  data 4E,75,4E,56,FF,FC,3E,B9,00,00,1B,3A,3F,39,00,00
1150  data 1D,80,3F,39,00,00,1D,A2,3F,39,00,00,1D,A0,42,67
1160  data 4E,B9,00,00,11,B2,50,8F,33,C0,00,00,1E,BE,3E,B9
1170  data 00,00,1B,3A,3F,39,00,00,1D,80,3F,39,00,00,1D,A2
1180  data 3F,39,00,00,1D,A0,3F,39,00,00,1E,BE,4E,B9,00,00
1190  data 11,EC,50,8F,2E,BC,00,00,1B,72,2F,3C,00,00,1D,C4
1200  data 2F,3C,00,00,1D,C8,2F,3C,00,00,1D,C6,3F,3C,00,04
1210  data 3F,39,00,00,1E,BE,4E,B9,00,00,12,5A,DF,FC,00,00
1220  data 00,10,4E,5E,4E,75,4E,56,FF,FC,4E,B9,00,00,0E,22
1230  data 2E,BC,00,00,1B,38,2F,3C,00,00,1D,7E,2F,3C,00,00
1240  data 1E,78,2F,3C,00,00,1E,BC,4E,B9,00,00,10,5C,DF,FC
1250  data 00,00,00,0C,33,C0,00,00,1B,70,2E,BC,00,00,14,90
1260  data 3F,39,00,00,1E,9A,4E,B9,00,00,10,9E,54,8F,33,C0
1270  data 00,00,1A,32,2E,BC,00,00,1E,98,2F,3C,00,00,1E,C2
1280  data 2F,3C,00,00,1E,CA,2F,3C,00,00,1E,C8,3F,3C,00,04
1290  data 42,67,4E,B9,00,00,12,5A,DF,FC,00,00,00,10,2E,BC
1300  data 00,00,14,9E,4E,B9,00,00,11,64,4A,40,66,12,2E,BC
1310  data 00,00,14,A9,3F,3C,00,01,4E,B9,00,00,0F,F0,54,8F
1320  data 2E,BC,00,00,1D,AA,42,67,42,67,4E,B9,00,00,11,7E
1330  data 58,8F,4A,40,66,12,2E,BC,00,00,14,E0,3F,3C,00,01
1340  data 4E,B9,00,00,0F,F0,54,8F,2E,BC,00,00,1D,AA,42,67
1350  data 42,67,4E,B9,00,00,11,7E,58,8F,2E,BC,00,00,1B,3A
1360  data 2F,3C,00,00,1D,80,2F,3C,00,00,1D,A2,2F,3C,00,00
1370  data 1D,A0,2F,39,00,00,1D,AA,4E,B9,00,00,10,12,DF,FC
1380  data 00,00,00,10,61,04,4E,5E,4E,75,4E,56,FF,FC,60,00
1390  data 00,BE,2E,BC,00,00,1B,74,2F,3C,00,00,1B,74,2F,3C
1400  data 00,00,1B,74,2F,3C,00,00,1B,74,2F,3C,00,00,1D,7A
1410  data 2F,3C,00,00,1C,78,42,67,42,67,2F,3C,00,00,1B,5E
1420  data 42,67,42,67,42,67,42,67,42,67,42,67,42,67,42,67
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1430  data 42,67,42,67,3F,3C,00,01,3F,3C,00,01,3F,3C,00,01
1440  data 3F,3C,00,13,4E,B9,00,00,0E,96,DF,FC,00,00,00,38
1450  data 33,C0,00,00,1A,34,08,39,00,04,00,00,1A,35,67,4E
1460  data 30,39,00,00,1B,5E,60,40,30,39,00,00,1B,66,B0,79
1470  data 00,00,1A,32,66,2E,61,00,FD,94,61,00,FD,E6,61,36
1480  data 3E,B9,00,00,1E,BE,4E,B9,00,00,12,26,3E,B9,00,00
1490  data 1E,BE,4E,B9,00,00,12,40,3E,B9,00,00,1B,6E,4E,B9
1500  data 00,00,0C,F8,60,08,60,06,B0,7C,00,28,67,BA,60,00
1510  data FF,42,4E,5E,4E,75,4E,56,FF,FC,2E,BC,00,00,1D,AA
1520  data 42,67,42,67,4E,B9,00,00,11,7E,58,8F,2E,BC,00,00
1530  data 1B,3A,2F,3C,00,00,1D,80,2F,3C,00,00,1D,A2,2F,3C
1540  data 00,00,1D,A0,2F,39,00,00,1D,AA,4E,B9,00,00,10,12
1550  data DF,FC,00,00,00,10,3E,B9,00,00,1B,3A,3F,39,00,00
1560  data 1D,80,3F,39,00,00,1D,A2,3F,39,00,00,1D,A0,42,67
1570  data 4E,B9,00,00,0F,96,50,8F,3E,B9,00,00,1B,3A,3F,39
1580  data 00,00,1D,80,3F,39,00,00,1D,A2,3F,39,00,00,1D,A0
1590  data 3F,3C,00,01,3F,3C,00,01,3F,3C,00,01,3F,3C,00,01
1600  data 3F,3C,00,01,4E,B9,00,00,0F,96,DF,FC,00,00,00,10
1610  data 3E,B9,00,00,1E,98,3F,39,00,00,1E,C2,42,67,42,67
1620  data 3F,3C,00,22,42,67,2F,39,00,00,1D,AA,4E,B9,00,00
1630  data 10,C0,DF,FC,00,00,00,0E,42,79,00,00,1E,C0,60,00
1640  data 09,54,42,57,2F,39,00,00,1D,AA,4E,B9,00,00,0F,74
1650  data 58,8F,33,C0,00,00,1D,7C,30,39,00,00,1D,7C,60,00
1660  data 09,1E,3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1B,3A
1670  data 3F,39,00,00,1D,80,3F,39,00,00,1D,A2,3F,39,00,00
1680  data 1D,A0,42,67,3F,3C,00,07,2F,39,00,00,1D,AA,4E,B9
1690  data 00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,01,42,67
1700  data 3F,39,00,00,1B,3A,3F,39,00,00,1D,80,3F,39,00,00
1710  data 1D,A2,3F,39,00,00,1D,A0,42,67,3F,3C,00,08,2F,39
1720  data 00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12
1730  data 3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F
1740  data 3E,BC,00,4D,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F
1750  data 60,00,08,A2,3E,BC,00,01,3F,3C,00,01,3F,39,00,00
1760  data 1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39
1770  data 00,00,1D,C6,42,67,3F,3C,00,08,2F,39,00,00,1D,AA
1780  data 4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,01
1790  data 42,67,3F,39,00,00,1B,72,3F,39,00,00,1D,C4,3F,39
1800  data 00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C,00,07
1810  data 2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00
1820  data 00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,12,CC
1830  data 54,8F,3E,BC,00,50,3F,3C,00,05,4E,B9,00,00,12,CC
1840  data 54,8F,60,00,08,10,3E,BC,00,01,3F,3C,00,01,3F,39
1850  data 00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8
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1860  data 3F,39,00,00,1D,C6,42,67,3F,3C,00,10,2F,39,00,00
1870  data 1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC
1880  data 00,01,42,67,3F,39,00,00,1B,72,3F,39,00,00,1D,C4
1890  data 3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C
1900  data 00,11,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC
1910  data 00,00,00,12,3E,BC,00,0F,3F,3C,00,05,4E,B9,00,00
1920  data 12,CC,54,8F,60,00,07,8E,3E,BC,00,01,3F,3C,00,01
1930  data 3F,39,00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00
1940  data 1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C,00,11,2F,39
1950  data 00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12
1960  data 3E,BC,00,01,42,67,3F,39,00,00,1B,72,3F,39,00,00
1970  data 1D,C4,3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67
1980  data 3F,3C,00,10,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A
1990  data DF,FC,00,00,00,12,3E,BC,00,12,3F,3C,00,05,4E,B9
2000  data 00,00,12,CC,54,8F,60,00,07,0C,3E,BC,00,01,3F,3C
2010  data 00,01,3F,39,00,00,1B,72,3F,39,00,00,1D,C4,3F,39
2020  data 00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C,00,0A
2030  data 2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00
2040  data 00,12,3E,BC,00,01,42,67,3F,39,00,00,1B,72,3F,39
2050  data 00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00,1D,C6
2060  data 42,67,3F,3C,00,0B,2F,39,00,00,1D,AA,4E,B9,00,00
2070  data 11,0A,DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C,00,05
2080  data 4E,B9,00,00,12,CC,54,8F,3E,BC,00,70,3F,3C,00,05
2090  data 4E,B9,00,00,12,CC,54,8F,3E,BC,00,01,3F,3C,00,05
2100  data 4E,B9,00,00,12,CC,54,8F,60,00,06,6A,3E,BC,00,01
2110  data 3F,3C,00,01,3F,39,00,00,1B,72,3F,39,00,00,1D,C4
2120  data 3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C
2130  data 00,0B,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC
2140  data 00,00,00,12,3E,BC,00,01,42,67,3F,39,00,00,1B,72
2150  data 3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00
2160  data 1D,C6,42,67,3F,3C,00,0A,2F,39,00,00,1D,AA,4E,B9
2170  data 00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C
2180  data 00,05,4E,B9,00,00,12,CC,54,8F,3E,BC,00,70,3F,3C
2190  data 00,05,4E,B9,00,00,12,CC,54,8F,42,57,3F,3C,00,05
2200  data 4E,B9,00,00,12,CC,54,8F,60,00,05,CA,3E,BC,00,01
2210  data 3F,3C,00,01,3F,39,00,00,1B,72,3F,39,00,00,1D,C4
2220  data 3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C
2230  data 00,0D,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC
2240  data 00,00,00,12,3E,BC,00,01,42,67,3F,39,00,00,1B,72
2250  data 3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00
2260  data 1D,C6,42,67,3F,3C,00,0E,2F,39,00,00,1D,AA,4E,B9
2270  data 00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,1B,3F,3C
2280  data 00,05,4E,B9,00,00,12,CC,54,8F,3E,BC,00,34,3F,3C
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2290  data 00,05,4E,B9,00,00,12,CC,54,8F,60,00,05,38,3E,BC
2300  data 00,01,3F,3C,00,01,3F,39,00,00,1B,72,3F,39,00,00
2310  data 1D,C4,3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67
2320  data 3F,3C,00,0E,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A
2330  data DF,FC,00,00,00,12,3E,BC,00,01,42,67,3F,39,00,00
2340  data 1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39
2350  data 00,00,1D,C6,42,67,3F,3C,00,0D,2F,39,00,00,1D,AA
2360  data 4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,1B
2370  data 3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,3E,BC,00,35
2380  data 3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,60,00,04,A6
2390  data 3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1B,72,3F,39
2400  data 00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00,1D,C6
2410  data 42,67,3F,3C,00,13,2F,39,00,00,1D,AA,4E,B9,00,00
2420  data 11,0A,DF,FC,00,00,00,12,3E,BC,00,01,42,67,3F,39
2430  data 00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8
2440  data 3F,39,00,00,1D,C6,42,67,3F,3C,00,14,2F,39,00,00
2450  data 1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC
2460  data 00,1B,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,3E,BC
2470  data 00,53,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,42,57
2480  data 3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,60,00,04,06
2490  data 3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1B,72,3F,39
2500  data 00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00,1D,C6
2510  data 42,67,3F,3C,00,14,2F,39,00,00,1D,AA,4E,B9,00,00
2520  data 11,0A,DF,FC,00,00,00,12,3E,BC,00,01,42,67,3F,39
2530  data 00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8
2540  data 3F,39,00,00,1D,C6,42,67,3F,3C,00,13,2F,39,00,00
2550  data 1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC
2560  data 00,1B,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,3E,BC
2570  data 00,54,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F,60,00
2580  data 03,74,3E,BC,00,01,3F,3C,00,01,3F,39,00,00,1B,72
2590  data 3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00
2600  data 1D,C6,42,67,3F,3C,00,16,2F,39,00,00,1D,AA,4E,B9
2610  data 00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,01,42,67
2620  data 3F,39,00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00
2630  data 1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C,00,17,2F,39
2640  data 00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12
2650  data 3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F
2660  data 3E,BC,00,4E,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F
2670  data 3E,BC,00,06,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F
2680  data 60,00,02,D2,3E,BC,00,01,3F,3C,00,01,3F,39,00,00
2690  data 1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39
2700  data 00,00,1D,C6,42,67,3F,3C,00,17,2F,39,00,00,1D,AA
2710  data 4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC,00,01
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2720  data 42,67,3F,39,00,00,1B,72,3F,39,00,00,1D,C4,3F,39
2730  data 00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C,00,16
2740  data 2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00
2750  data 00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00,12,CC
2760  data 54,8F,3E,BC,00,4F,3F,3C,00,05,4E,B9,00,00,12,CC
2770  data 54,8F,60,00,02,40,3E,BC,00,01,3F,3C,00,01,3F,39
2780  data 00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8
2790  data 3F,39,00,00,1D,C6,42,67,3F,3C,00,1A,2F,39,00,00
2800  data 1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC
2810  data 00,01,42,67,3F,39,00,00,1B,72,3F,39,00,00,1D,C4
2820  data 3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C
2830  data 00,19,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC
2840  data 00,00,00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00
2850  data 12,CC,54,8F,3E,BC,00,6C,3F,3C,00,05,4E,B9,00,00
2860  data 12,CC,54,8F,42,57,3F,3C,00,05,4E,B9,00,00,12,CC
2870  data 54,8F,60,00,01,A0,3E,BC,00,01,3F,3C,00,01,3F,39
2880  data 00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00,1D,C8
2890  data 3F,39,00,00,1D,C6,42,67,3F,3C,00,19,2F,39,00,00
2900  data 1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12,3E,BC
2910  data 00,01,42,67,3F,39,00,00,1B,72,3F,39,00,00,1D,C4
2920  data 3F,39,00,00,1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C
2930  data 00,1A,2F,39,00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC
2940  data 00,00,00,12,3E,BC,00,1B,3F,3C,00,05,4E,B9,00,00
2950  data 12,CC,54,8F,3E,BC,00,6C,3F,3C,00,05,4E,B9,00,00
2960  data 12,CC,54,8F,3E,BC,00,0A,3F,3C,00,05,4E,B9,00,00
2970  data 12,CC,54,8F,60,00,00,FE,3E,BC,00,01,3F,3C,00,01
2980  data 3F,39,00,00,1B,72,3F,39,00,00,1D,C4,3F,39,00,00
2990  data 1D,C8,3F,39,00,00,1D,C6,42,67,3F,3C,00,05,2F,39
3000  data 00,00,1D,AA,4E,B9,00,00,11,0A,DF,FC,00,00,00,12
3010  data 3E,BC,00,0D,3F,3C,00,05,4E,B9,00,00,12,CC,54,8F
3020  data 3E,B9,00,00,1B,3A,3F,39,00,00,1D,80,3F,39,00,00
3030  data 1D,A2,3F,39,00,00,1D,A0,3F,3C,00,02,4E,B9,00,00
3040  data 0F,96,50,8F,3E,B9,00,00,1B,3A,3F,39,00,00,1D,80
3050  data 3F,39,00,00,1D,A2,3F,39,00,00,1D,A0,3F,3C,00,01
3060  data 3F,3C,00,01,3F,3C,00,01,3F,3C,00,01,3F,3C,00,03
3070  data 4E,B9,00,00,0F,96,DF,FC,00,00,00,10,33,FC,00,01
3080  data 00,00,1E,C0,3E,BC,00,01,42,67,3F,39,00,00,1B,72
3090  data 3F,39,00,00,1D,C4,3F,39,00,00,1D,C8,3F,39,00,00
3100  data 1D,C6,42,67,3F,3C,00,05,2F,39,00,00,1D,AA,4E,B9
3110  data 00,00,11,0A,DF,FC,00,00,00,12,60,18,60,16,5B,40
3120  data B0,7C,00,15,62,0E,E5,40,30,40,D1,FC,00,00,14,38
3130  data 20,50,4E,D0,0C,79,00,01,00,00,1E,C0,66,00,F6,A4
3140  data 4E,5E,4E,75,4E,56,FF,FC,33,FC,00,65,00,00,1E,9C
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```
3150  data 42,79,00,00,1E,9E,42,79,00,00,1E,A2,33,EE,00,08
3160  data 00,00,1E,A8,4E,B9,00,00,0D,A2,4E,5E,4E,75,4E,56
3170  data FF,FC,23,EE,00,08,00,00,19,1E,23,EE,00,10,00,00
3180  data 19,26,20,2E,00,10,D0,BC,00,00,00,5A,23,C0,00,00
3190  data 19,2A,33,FC,00,64,00,00,1E,9C,42,79,00,00,1E,9E
3200  data 33,FC,00,0B,00,00,1E,A2,20,6E,00,0C,33,D0,00,00
3210  data 1E,A8,4E,B9,00,00,0D,A2,20,6E,00,0C,30,B9,00,00
3220  data 1E,A8,23,FC,00,00,19,32,00,00,19,1E,23,FC,00,00
3230  data 1A,38,00,00,19,26,23,FC,00,00,1C,7A,00,00,19,2A
3240  data 23,FC,00,00,1B,78,00,00,19,22,4E,5E,4E,75,23,FC
3250  data 00,00,1E,9C,00,00,19,1A,22,3C,00,00,19,1A,70,73
3260  data 4E,42,4E,75,4E,56,FF,F6,33,EE,00,08,00,00,1D,CE
3270  data 30,2E,00,08,D0,7C,FF,F6,C1,FC,00,03,48,C0,D0,BC
3280  data 00,00,12,DC,2D,40,FF,FA,3D,7C,00,01,FF,FE,60,1E
3290  data 20,6E,FF,FA,10,10,48,80,32,6E,FF,FE,D3,C9,D3,FC
3300  data 00,00,1D,CE,32,80,52,AE,FF,FA,52,6E,FF,FE,0C,6E
3310  data 00,04,FF,FE,6D,DA,2E,B9,00,00,1E,92,4E,B9,00,00
3320  data 00,14,42,40,30,39,00,00,1D,F6,4E,5E,4E,75,4E,56
3330  data FF,FA,23,FC,00,00,1D,CE,00,00,1B,3E,23,FC,00,00
3340  data 1D,82,00,00,1B,42,23,FC,00,00,1D,D6,00,00,1B,46
3350  data 23,FC,00,00,1D,F6,00,00,1B,4A,23,FC,00,00,1E,B4
3360  data 00,00,1B,4E,23,FC,00,00,1E,C4,00,00,1B,52,23,FC
3370  data 00,00,1B,3E,00,00,1E,92,3E,BC,00,0A,61,00,FF,46
3380  data 33,F9,00,00,1D,F6,00,00,1E,9A,70,01,4E,5E,4E,75
3390  data 4E,56,FF,FC,3E,BC,00,13,61,00,FF,2A,70,01,4E,5E
3400  data 4E,75,4E,56,FF,FC,33,EE,00,08,00,00,1D,D6,33,EE
3410  data 00,0A,00,00,1D,D8,33,EE,00,0C,00,00,1D,DA,33,EE
3420  data 00,0E,00,00,1D,DC,33,EE,00,10,00,00,1D,DE,33,EE
3430  data 00,12,00,00,1D,E0,33,EE,00,14,00,00,1D,E2,33,EE
3440  data 00,16,00,00,1D,E4,33,EE,00,18,00,00,1D,E6,33,EE
3450  data 00,1A,00,00,1D,E8,33,EE,00,1C,00,00,1D,EA,33,EE
3460  data 00,1E,00,00,1D,EC,33,EE,00,20,00,00,1D,EE,33,EE
3470  data 00,22,00,00,1D,F0,23,EE,00,24,00,00,1E,B4,33,EE
3480  data 00,28,00,00,1D,F2,33,EE,00,2A,00,00,1D,F4,3E,BC
3490  data 00,19,4E,B9,00,00,0D,B8,20,6E,00,2C,30,B9,00,00
3500  data 1D,F8,20,6E,00,30,30,B9,00,00,1D,FA,20,6E,00,34
3510  data 30,B9,00,00,1D,FC,20,6E,00,38,30,B9,00,00,1D,FE
3520  data 20,6E,00,3C,30,B9,00,00,1E,00,20,6E,00,40,30,B9
3530  data 00,00,1E,02,42,40,30,39,00,00,1D,F6,4E,5E,4E,75
3540  data 4E,56,FF,FC,23,EE,00,08,00,00,1E,B4,33,EE,00,0C
3550  data 00,00,1D,D6,3E,BC,00,32,4E,B9,00,00,0D,B8,4E,5E
3560  data 4E,75,4E,56,FF,FC,33,EE,00,08,00,00,1D,D6,33,EE
3570  data 00,0A,00,00,1D,D8,33,EE,00,0C,00,00,1D,DA,33,EE
```

```
3580  data 00,0E,00,00,1D,DC,33,EE,00,10,00,00,1D,DE,33,EE
3590  data 00,12,00,00,1D,E0,33,EE,00,14,00,00,1D,E2,33,EE
3600  data 00,16,00,00,1D,E4,33,EE,00,18,00,00,1D,E6,3E,BC
3610  data 00,33,4E,B9,00,00,0D,B8,4E,5E,4E,75,4E,56,FF,FC
3620  data 33,EE,00,08,00,00,1D,D6,23,EE,00,0A,00,00,1E,B4
3630  data 3E,BC,00,34,4E,B9,00,00,0D,B8,4E,5E,4E,75,4E,56
3640  data FF,FC,23,EE,00,08,00,00,1E,B4,3E,BC,00,36,4E,B9
3650  data 00,00,0D,B8,20,6E,00,0C,30,B9,00,00,1D,F8,20,6E
3660  data 00,10,30,B9,00,00,1D,FA,20,6E,00,14,30,B9,00,00
3670  data 1D,FC,20,6E,00,18,30,B9,00,00,1D,FE,42,40,30,39
3680  data 00,00,1D,F6,4E,5E,4E,75,4E,56,FF,FC,3E,BC,00,4D
3690  data 4E,B9,00,00,0D,B8,20,6E,00,08,30,B9,00,00,1D,F8
3700  data 20,6E,00,0C,30,B9,00,00,1D,FA,20,6E,00,10,30,B9
3710  data 00,00,1D,FC,20,6E,00,14,30,B9,00,00,1D,FE,42,40
3720  data 30,39,00,00,1D,F6,4E,5E,4E,75,4E,56,FF,FC,33,EE
3730  data 00,08,00,00,1D,D6,23,EE,00,0A,00,00,1E,B4,3E,BC
3740  data 00,23,4E,B9,00,00,0D,B8,4E,5E,4E,75,4E,56,FF,FC
3750  data 23,EE,00,08,00,00,1E,B4,33,EE,00,0C,00,00,1D,D6
3760  data 33,EE,00,0E,00,00,1D,D8,33,EE,00,10,00,00,1D,DA
3770  data 33,EE,00,12,00,00,1D,DC,33,EE,00,14,00,00,1D,DE
3780  data 33,EE,00,16,00,00,1D,E0,3E,BC,00,2A,4E,B9,00,00
3790  data 0D,B8,4E,5E,4E,75,4E,56,FF,FC,23,EE,00,08,00,00
3800  data 1E,B4,33,EE,00,0C,00,00,1D,D6,33,EE,00,0E,00,00
3810  data 1D,D8,33,EE,00,10,00,00,1D,DA,33,EE,00,12,00,00
3820  data 1D,DC,33,EE,00,14,00,00,1D,DE,33,EE,00,16,00,00
3830  data 1D,E0,33,EE,00,18,00,00,1D,E2,33,EE,00,1A,00,00
3840  data 1D,E4,3E,BC,00,2F,4E,B9,00,00,0D,B8,4E,5E,4E,75
3850  data 4E,56,FF,FC,23,EE,00,08,00,00,1E,B4,3E,BC,00,6E
3860  data 4E,B9,00,00,0D,B8,4E,5E,4E,75,4E,56,FF,FC,33,EE
3870  data 00,08,00,00,1D,D6,33,EE,00,0A,00,00,1D,D8,3E,BC
3880  data 00,70,4E,B9,00,00,0D,B8,20,6E,00,0C,20,B9,00,00
3890  data 1E,C4,42,40,30,39,00,00,1D,F6,4E,5E,4E,75,4E,56
3900  data FF,FC,33,EE,00,08,00,00,1D,D6,33,EE,00,0A,00,00
3910  data 1D,D8,33,EE,00,0C,00,00,1D,DA,33,EE,00,0E,00,00
3920  data 1D,DC,33,EE,00,10,00,00,1D,DE,3E,BC,00,64,4E,B9
3930  data 00,00,0D,B8,4E,5E,4E,75,4E,56,FF,FC,33,EE,00,08
3940  data 00,00,1D,D6,33,EE,00,0A,00,00,1D,D8,33,EE,00,0C
3950  data 00,00,1D,DA,33,EE,00,0E,00,00,1D,DC,33,EE,00,10
3960  data 00,00,1D,DE,3E,BC,00,65,4E,B9,00,00,0D,B8,4E,5E
3970  data 4E,75,4E,56,FF,FC,33,EE,00,08,00,00,1D,D6,3E,BC
3980  data 00,66,4E,B9,00,00,0D,B8,4E,5E,4E,75,4E,56,FF,FC
3990  data 33,EE,00,08,00,00,1D,D6,3E,BC,00,67,4E,B9,00,00
4000  data 0D,B8,4E,5E,4E,75,4E,56,FF,FC,33,EE,00,08,00,00
```

```
4010  data 1D,D6,33,EE,00,0A,00,00,1D,D8,3E,BC,00,68,4E,B9
4020  data 00,00,0D,B8,20,6E,00,0C,30,B9,00,00,1D,F8,20,6E
4030  data 00,10,30,B9,00,00,1D,FA,20,6E,00,14,30,B9,00,00
4040  data 1D,FC,20,6E,00,18,30,B9,00,00,1D,FE,42,40,30,39
4050  data 00,00,1D,F6,4E,5E,4E,75,23,DF,00,00,19,2E,4E,4E
4060  data 2F,39,00,00,19,2E,4E,75,23,DF,00,00,19,2E,4E,4D
4070  data 2F,39,00,00,19,2E,4E,75,23,DF,00,00,19,2E,4E,41
4080  data 2F,39,00,00,19,2E,4E,75,00,01,00,02,01,01,02,01
4090  data 01,00,01,01,02,01,01,01,01,01,00,00,00,00,00,00
4100  data 00,00,00,00,01,00,00,01,00,03,05,00,05,05,00,00
4110  data 01,01,02,01,00,10,07,01,02,01,00,00,00,00,00,00
4120  data 00,00,00,00,01,01,01,02,01,01,02,01,01,02,01,01
4130  data 01,01,02,01,01,01,00,00,00,00,00,00,00,00,00,00
4140  data 00,00,02,01,01,01,01,01,06,01,01,04,01,01,01,03
4150  data 01,02,01,01,04,02,01,08,01,01,00,00,00,00,00,00
4160  data 01,01,01,09,01,01,01,01,01,01,01,00,00,05,01,00
4170  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4180  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4190  data 00,00,00,00,00,00,00,00,00,00,00,00,04,03,00,08
4200  data 03,00,06,01,00,08,01,00,08,01,00,04,01,01,03,01
4210  data 01,00,05,00,01,01,01,00,05,00,00,01,01,00,01,01
4220  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4230  data 00,00,00,00,00,00,00,00,00,02,02,00,00,00,00,00
4240  data 00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00
4250  data 00,00,00,00,00,00,05,01,00,05,01,00,01,01,00,01
4260  data 01,00,02,05,00,06,01,00,02,01,00,01,01,00,06,05
4270  data 00,00,00,00,00,01,01,00,01,00,02,01,00,02,01,01
4280  data 01,01,01,00,00,00,00,00,00,00,00,00,00,00,00,00
4290  data 00,00,00,01,02,03,01,02,01,01,01,01,01,01,00,01
4300  data 01,00,01,02,00,00,0B,EC,00,00,0C,E8,00,00,03,B6
4310  data 00,00,04,48,00,00,0C,E8,00,00,05,DE,00,00,06,80
4320  data 00,00,0C,E8,00,00,07,20,00,00,07,B2,00,00,0C,E8
4330  data 00,00,04,DA,00,00,05,5C,00,00,0C,E8,00,00,08,44
4340  data 00,00,08,E4,00,00,0C,E8,00,00,09,76,00,00,0A,18
4350  data 00,00,0C,E8,00,00,0B,4A,00,00,0A,AA,20,20,46,58
4360  data 2D,38,30,2B,20,49,4E,49,54,00,50,52,49,4E,49,54
4370  data 2E,52,53,43,00,5B,33,5D,5B,42,61,64,20,63,6F,70
4380  data 79,3F,20,7C,50,52,49,4E,49,54,2E,52,53,43,7C,20
4390  data 63,6F,75,6C,64,6E,27,74,20,62,65,20,66,6F,75,6E
4400  data 64,21,5D,5B,43,61,6E,63,65,6C,5D,00,5B,33,5D,20
4410  data 5B,46,61,74,61,6C,20,65,72,72,6F,72,21,21,7C,52
4420  data 65,73,6F,75,72,63,65,20,46,69,6C,65,20,6E,6F,74
4430  data 20,4F,4B,2E,5D,5B,43,61,6E,63,65,6C,5D,00,00,00
```

```
4440  data 00,02,06,2A,18,06,04,06,06,06,06,10,06,06,06,08
4450  data 08,06,06,06,06,06,06,08,06,06,06,0A,06,14,06,06
4460  data 06,06,06,0C,06,06,06,08,06,06,06,06,0C,0C,06,0A
4470  data 0A,08,0A,0C,0A,08,0A,08,06,06,06,06,06,1A,06,06
4480  data 06,06,06,0A,2A,0C,08,08,08,06,12,06,06,06,06,06
4490  data 1C,0A,08,06,06,06,06,06,0C,06,06,06,08,08,06,06
4500  data 06,1A,0C,06,10,06,0C,0C,06,08,06,12,06,06,06,0C
4510  data 06,12,06,06,06,0C,06,14,10,14,06,06,06,0C,06,12
4520  data 06,06,06,0C,06,14,10,14,06,06,06,0C,06,12,06,06
4530  data 06,0C,06,14,14,06,06,06,0C,06,12,06,06,06,0C,06
4540  data 14,14,06,06,06,0C,06,12,06,06,06,0C,06,14,10,10
4550  data 14,06,06,06,0C,06,12,06,06,06,0C,06,14,10,0E,14
4560  data 06,06,06,0C,06,12,06,06,06,0C,06,14,10,14,06,06
4570  data 06,0C,06,12,06,06,06,0C,06,14,10,14,06,06,06,0C
4580  data 06,12,06,06,06,0C,06,14,10,0E,14,06,06,06,0C,06
4590  data 12,06,06,06,0C,06,14,10,14,06,06,06,0C,06,12,06
4600  data 06,06,0C,06,14,10,10,14,06,06,06,0C,06,12,06,06
4610  data 06,0C,06,14,10,14,06,06,06,0C,06,12,06,06,06,0C
4620  data 06,14,10,0E,14,06,06,06,0C,06,12,06,06,06,0C,06
4630  data 14,10,10,14,06,06,06,0C,06,14,08,06,06,06,0A,08
4640  data 06,06,06,1A,0E,0C,06,06,06,0C,06,1C,0C,14,06,06
4650  data 08,06,10,08,10,08,06,08,0A,06,0A,06,04,06,04,06
4660  data 04,06,04,0A,04,06,12,14,20,18,06,08,0E,04,06,04
4670  data 06,04,06,04,06,04,06,04,06,04,0E,04,24,08,08,08
4680  data 08,08,08,08,08,08,08,08,08,08,08,08,08,0A,0A,0A
4690  data 0A,0A,0A,0A,08,10,08,0A,10,08,08,08,08,08,08,08
4700  data 08,0A,10,08,0A,10,0A,0A,0A,0A,0A,08,12,0A,0A,0A
4710  data 0A,08,10,08,0A,10,08,08,08,08,08,08,0A,10,08,08
4720  data 08,08,08,08,08,08,0A,10,0A,10,08,0A,0A,08,10,08
4730  data 08,08,08,0A,10,08,08,08,08,0A,10,0A,10,0A,10,08
4740  data 0A,0A,0A,0A,0A,08,0A,08,08,08,08,08,01,64,04,04
4750  data 04,04,04,04,04,04,04,04,04,04,04,04,04,04,04,04
4760  data 04,04,04,00,00,00,00,00,00,00,00,00,00,00,00,00
4770  data *
4780  close 1:if s<> 340260 then print"ERROR IN DATA!":end
4800  print "Ok."
```

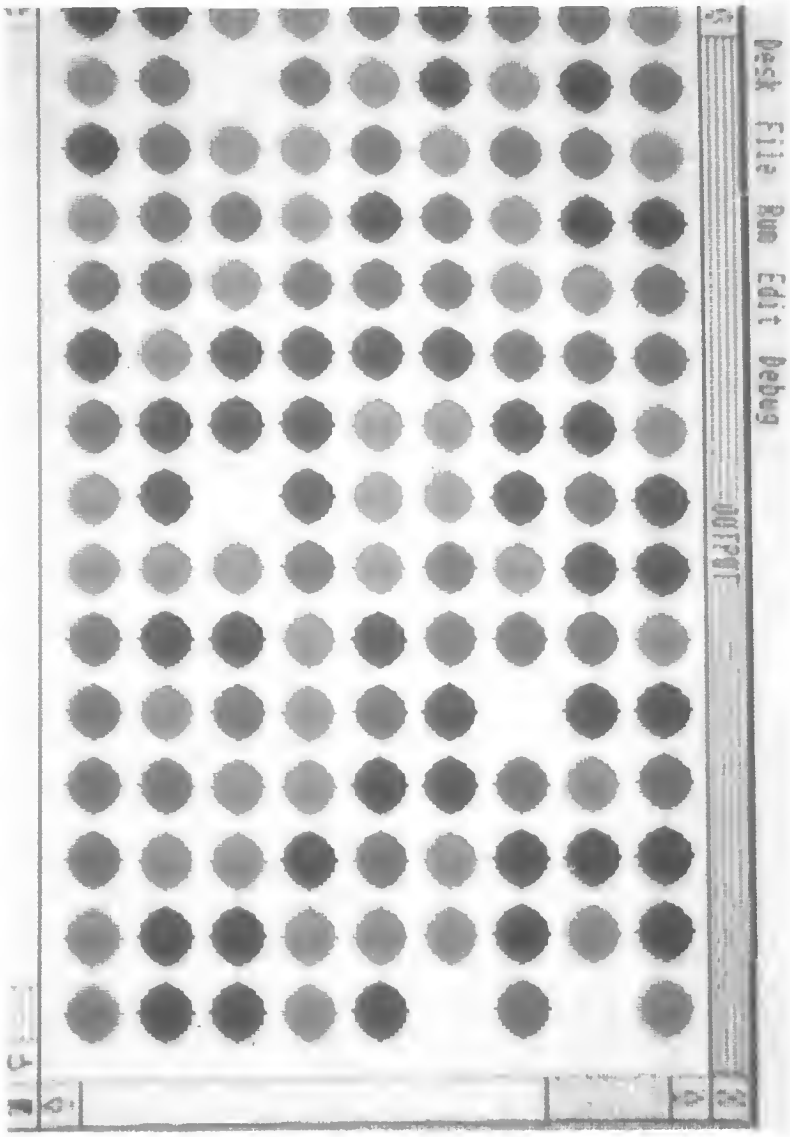
# Color Plates

Plate 1 Actual screen photograph
Plate 2 Epson JX-80 color hardcopy of Plate 1
Plate 3 Actual screen photograph
Plate 4 Epson JX-80 color hardcopy of Plate 3
Plate 5 Actual screen photograph
Plate 6 Epson HI-80 plotter hardcopy of Plate 5
Plate 7 Epson JX-80 color hardcopy of Plate 5
Plate 8 Epson HI-80 plotter hardcopy
Plate 9 Actual screen photograph
Plate 10 Epson JX-80 color hardcopy of Plate 9

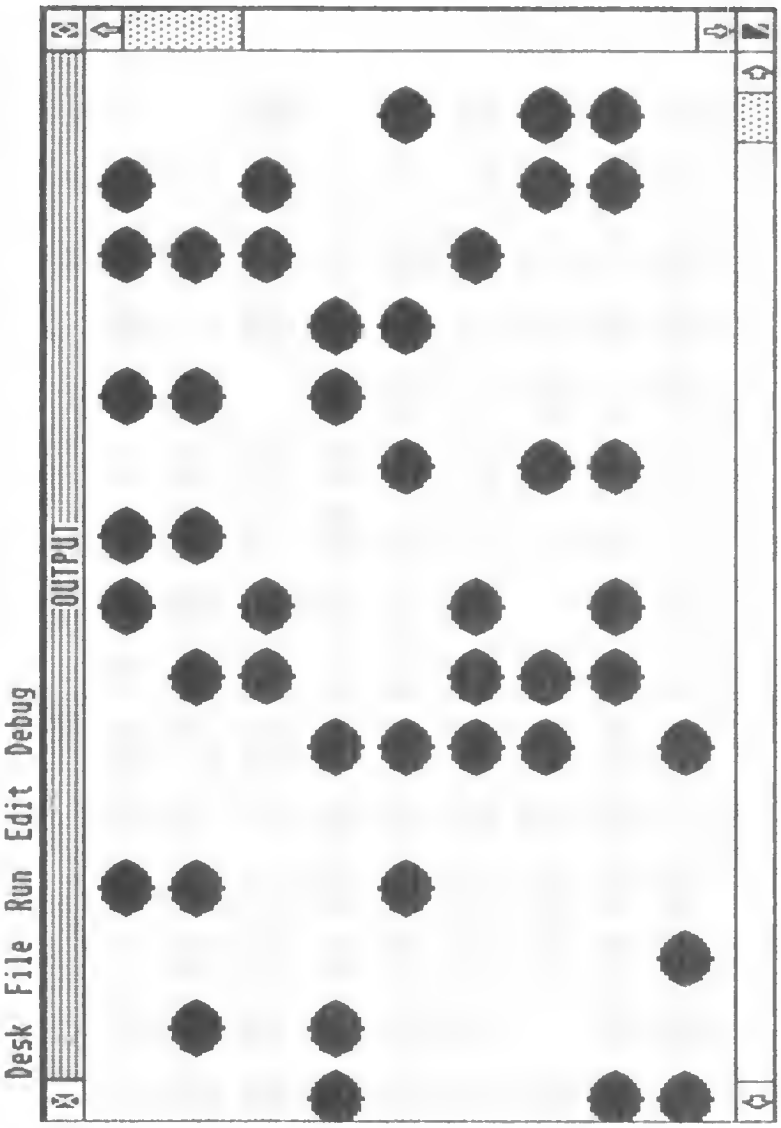
## Plate 1 Actual screen photograph

## Plate 2 Epson JX-80 color hardcopy of Plate 1

## Plate 3 Actual screen photograph



## Plate 4 Epson JX-80 color hardcopy of Plate 3



## Plate 5 Actual screen photograph

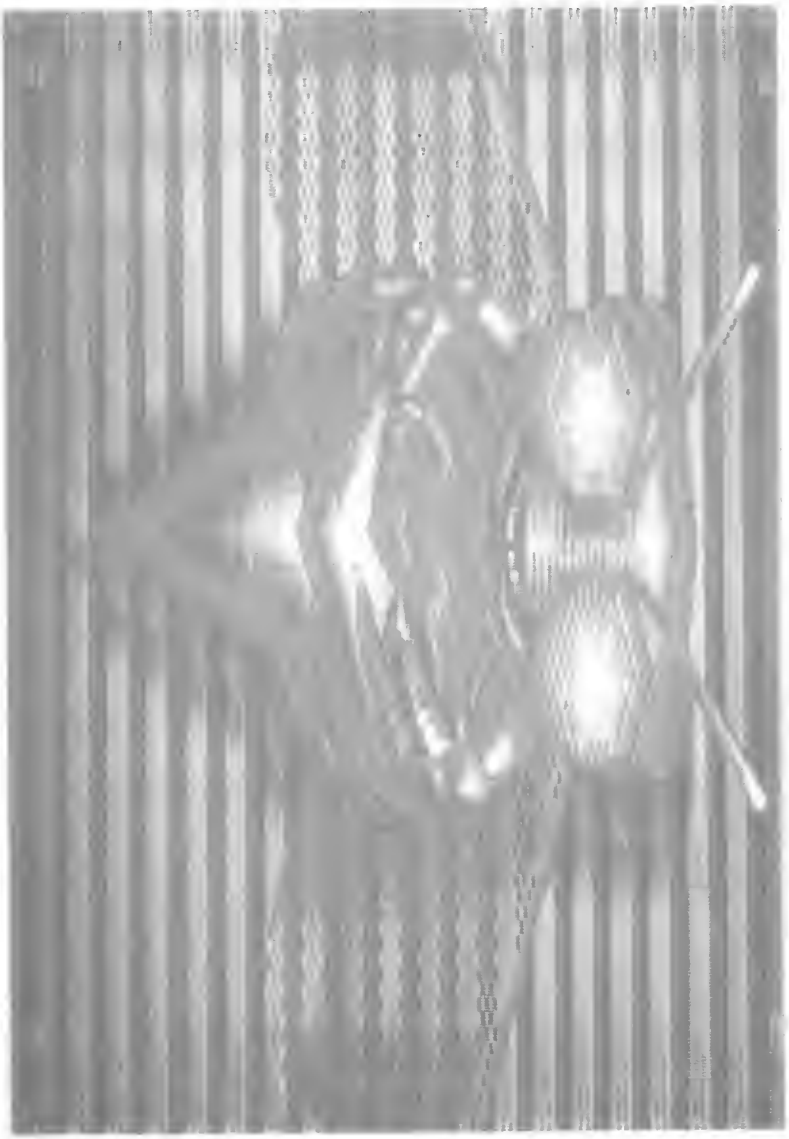
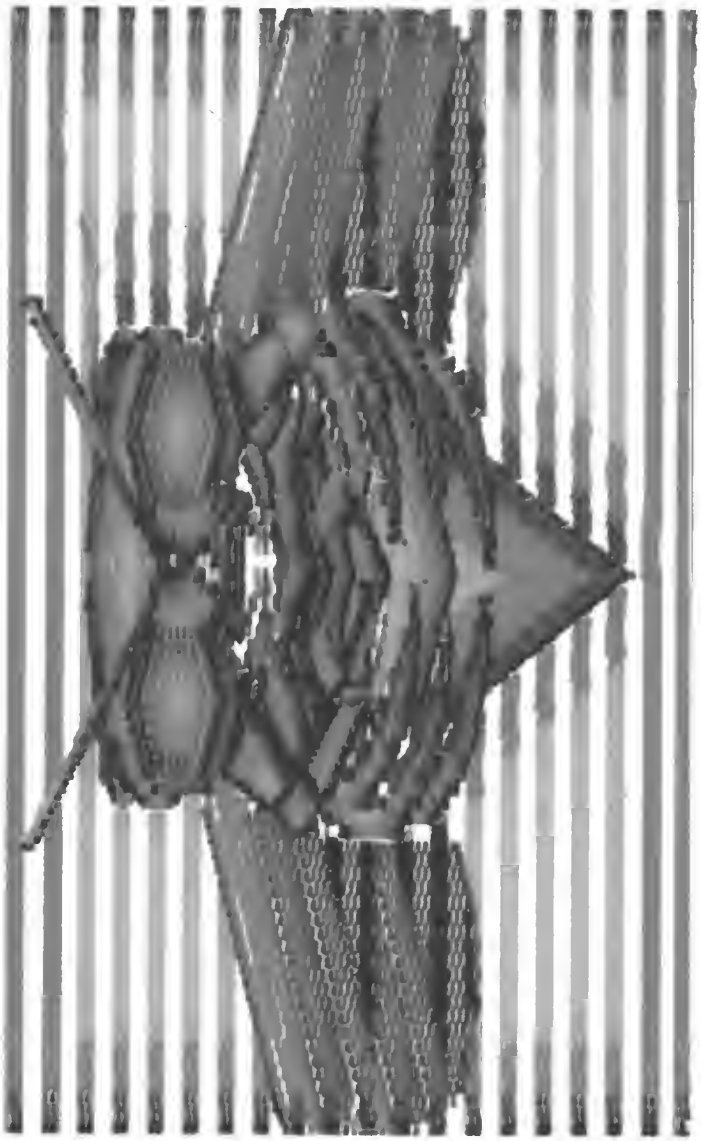
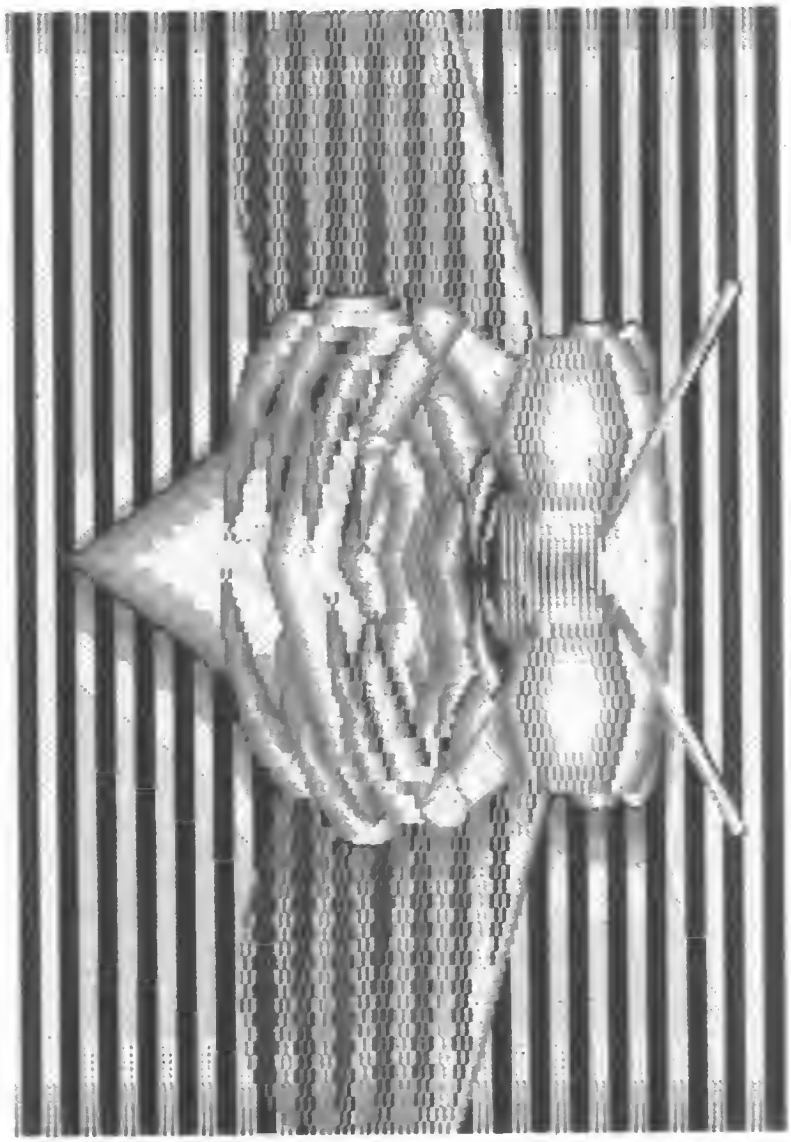


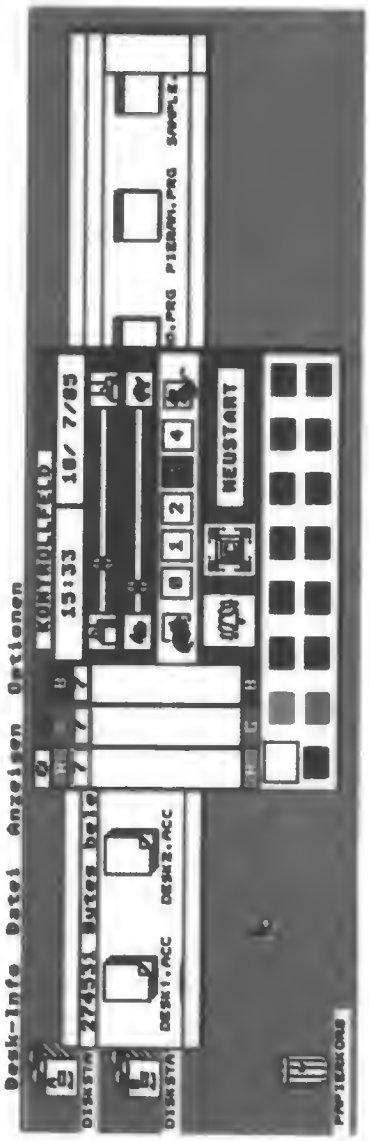
**Plate 6 Epson HI-80 plotter hardcopy of Plate 5**



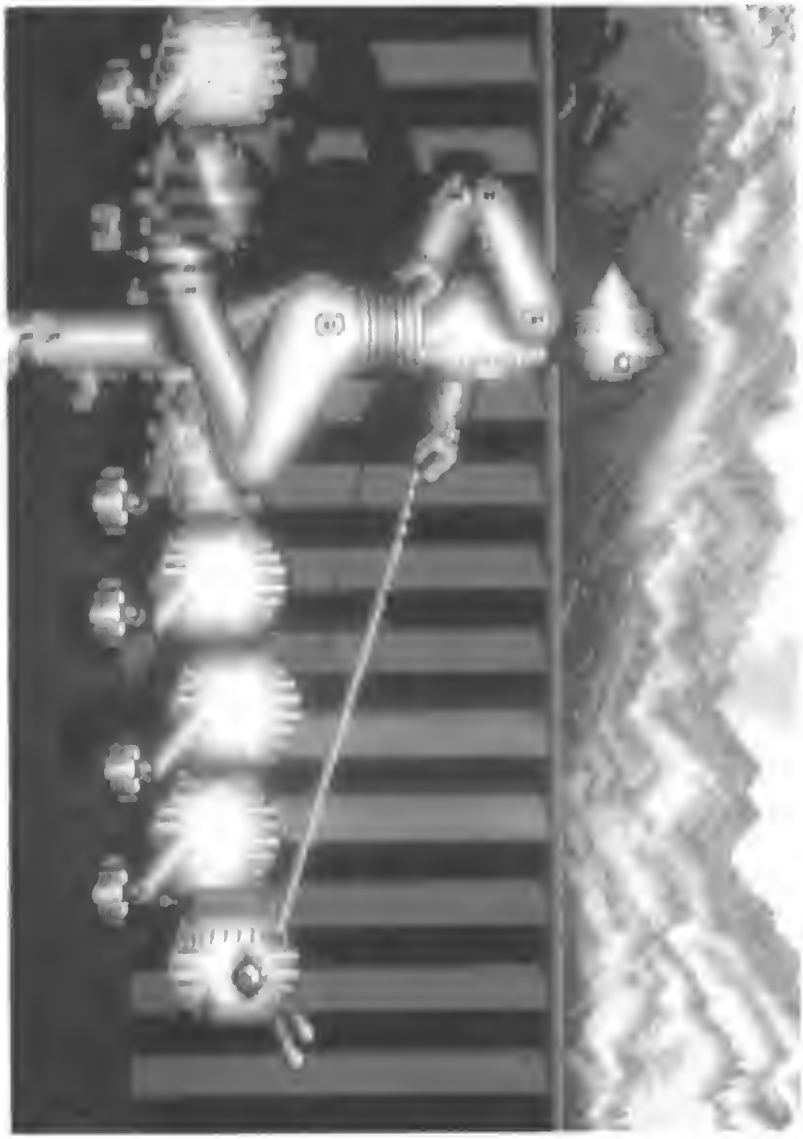
## Plate 7 Epson JX-80 color hardcopy of Plate 5



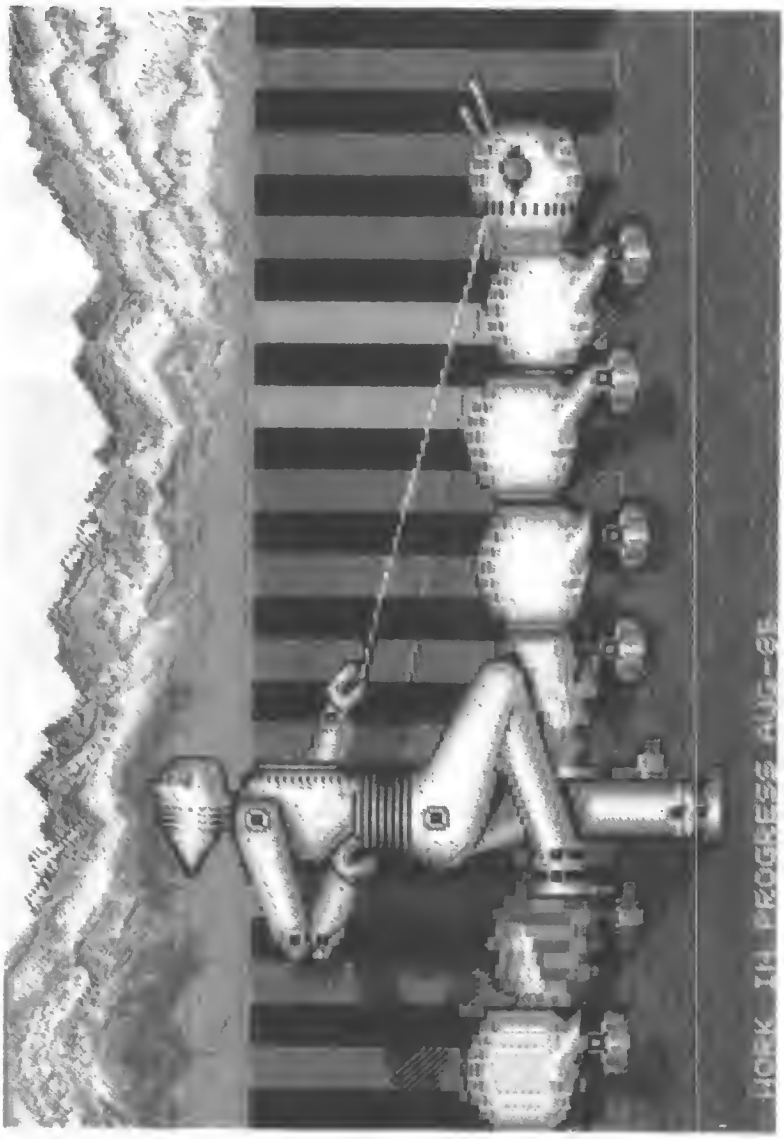
## Plate 8 Epson HI-80 plotter hardcopy



## Plate 9 Actual screen photograph



## Plate 10 Epson JX-80 color hardcopy of Plate 9



# APPENDICES

## Appendix A

The following program creates a table of the Atari ST character set. To use the table, choose the character you want to display. For example, let's use the copyright symbol (©). In the table, find the row (B) and column (D) in which it appears. This yeilds a hexadecimal nymber ($BD). To display it, we use the CHR$ function, so to print the copyright symbol to the screen type:

```
print chr$(&hBD)
```

The &h tells the computer this is a hexadecimal number.

Perhaps you might want to printout a formula such as: $x^2y + xy^3 = 0$. We would need to look up the values for the superscripted 2 and 3. These are FD and FE. To display these, type the following:

```
print "x"chr$(&hFD)"y + xy"chr$(&hFE)" = 0"
```

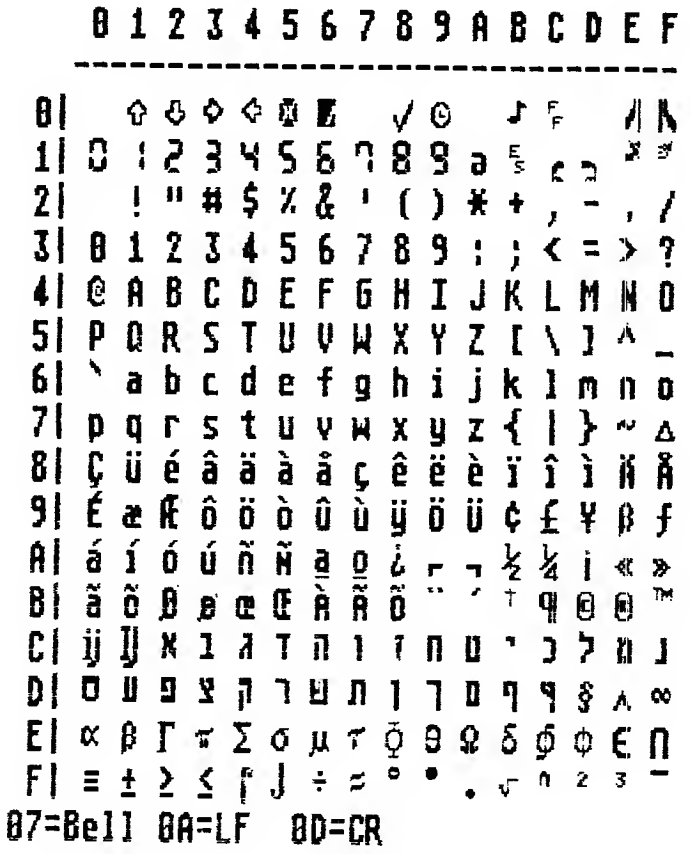
By using the table, you can display characters not easily accessible from the keyboard.

### BASIC program to create a character set table for the ST

```
1000 fullw 2:clearw 2
1010 print"    ";:for j%=0 to 15 'create column #s
1020 print hex$(j%)" ";
1030 next j%
1040 print:print"   ";:for j%=1 to 32
1050 print chr$(&h2d); '2d is chr code for dash
1060 next j%
1070 print
1080 for i%=0 to 15
1090 print " "hex$(i%)chr$(&h7c)" "; '7c code for vert bar
1100 for j%=0 to 15
1110 c% = i% * 16 + j% 'calculate char number
1120 if c%=7 or c%=10 or c%=13 then print"  ";:goto 1140
```

```
1130 print chr$(c%)" ";
1140 next j%:print
1150 next i%
1160 print "07=Bell 0A=LF 0D=CR" 'remove on color monitor
1170 poke 1262,0 'hardcopy to printer
1180 end
```

## ST character set table



## Appendix B

The following is a list of the commands available in ST BASIC.

| | | |
|---|---|---|
| ABS | ALL | AND |
| AS | ASC | ATN |
| AUTO | BASE | BLOAD |
| BREAK | BSAVE | CALL |
| CBDL | CHAIN | CHR$ |
| CINT | CIRCLE | CLEAR |
| CLEARW | CLOSE | CLOSEW |
| COLOR | COMMON | CONT |
| CONTROL | COS | CSNG |
| CVD | CVI | CVS |
| DATA | DEF FN | DEF SEG |
| DEFFBL | DEFINT | DEFSNG |
| DEFSTR | DELETE | DIM |
| DIR | ED | EDIT |
| ELLIPSE | ELSE | END |
| EOF | EQF | ERA |
| ERASE | ERL | ERR |
| ERROR | EXP | FIELD |
| FIELD# | FILL | FIX |
| FLOAT | FOLLOW | FOR |
| FRE | FULLW | GEMSYS |
| GB | GET | GET# |
| GO | GOSUB | GOTO |
| GOTOXY | HEX$ | IF |
| IMP | INKEY$ | INP |
| INPUT | INPUT# | INPUT$ |
| INSTR | INTIN | INTOUT |
| KILL | LEFT$ | LEN |
| LET | LINE INPUT | LINE INPUT# |
| LINEF | LIST | LLIST |
| LOAD | LOC | LOF |
| LOG10 | LPOS | LPRINT |
| LSET | MERGE | MID$ |
| MKD$ | MKS$ | MOD |
| NAME | MEW | MEXT |
| NOT | OCT$ | OLD |
| ON | OPEN | OPENW |
| OPTION | OR | OUT |

| | | |
|---|---|---|
| PCIRCLE | PEEK | PELLIPSE |
| POKE | POS | PRINT |
| PRINT# | PRINT USING | PTSIN |
| PTSOUT | PUT | QUIT |
| RANDOMIZE | READ | REM |
| RENUM | REPLACE | RESET |
| RESTORE | RESUME | RETURN |
| RIGHT$ | RND | RSET |
| RUN | SAVE | SGN |
| SIN | SOUND | SPACE$ |
| SPC | SQR | STEP |
| STOP | STR$ | STRING$ |
| SWAP | SYSDBG | SYSTAB |
| SYSTEM | TAB | TAN |
| THEN | TO | TRACE |
| TROFF | TRON | UNBREAK |
| UNFOLLOW | UNTRACE | USING |
| VAL | VARPTR | VDISYS |
| WAIT | WAVE | WEND |
| WHILE | WIDTH | WRITE |
| WRITE# | XOR | |

# Index

## P



## R



## S

## W



## Y

# Calling All Authors

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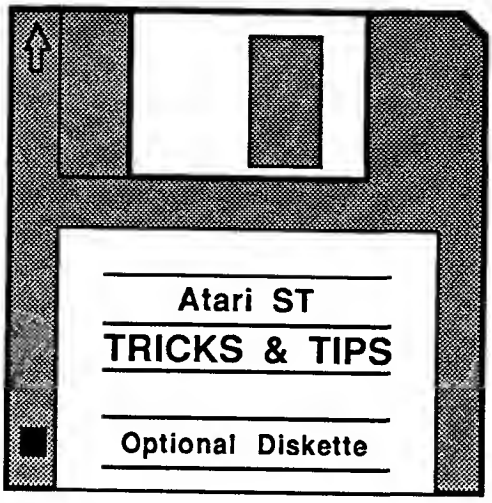


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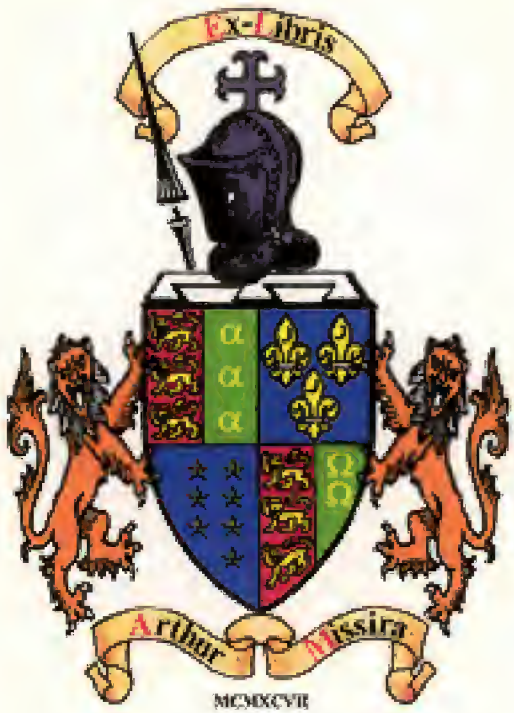
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